Low-Moisture Foods: Food Safety Challenges and Opportunities

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Overview

- Background History
- Pathogen Survival and Resistance
- Outbreaks: Learnings
- Interventions Opportunities

What are low-moisture foods?
Also known as low-A_w foods?

- Water activity < 0.7
  - Microbiologically stable
  - Long ambient shelf life
- Ingredients (often)
  - Challenging epidemiology
- Final preparation
  - Not always cooked
2014 WHO/FAO Risk Ranking of Low Moisture Foods - bacterial foodborne illness

Trade, burden of disease, consumption, production

1. Cereals and grains
2. Dried protein products
3. Spices, dried herbs, tea
4. Nuts and nut products
5. Confections and snacks
6. Dried fruits and vegetables
7. Seeds for consumption

Honey, pet food, infant formula (excluded from ranking)

Report available at FAO website

1970s and 1980s – Salmonella in chocolate

- 1970 Sweden; chocolate products
  - Contaminated cocoa powder
- 1973-74 Canada and U.S.; chocolate balls
  - Contaminated cocoa beans
- 1982 UK and Wales; Italian chocolate bars
  - Contaminated water suspected
- 1985/86 Canada and U.S.; Belgian chocolate coins
- 1987 Norway and Finland; Norwegian chocolate products

- Control (mostly) of Salmonella
  - Outbreaks occur occasionally

Historical concern – 1950 -1970

- Salmonella associated with:
  - Dried milk
  - Dried eggs and egg components
  - Dried animal feeds
  - Dried coconut

- Control (mostly) of Salmonella
- Skim milk powder outbreaks still occur:

Historical concern – 1980s

- Emergence of Cronobacter sakazakii
  - Formerly Enterobacter sakazakii
  - Primarily concern in powdered infant formula
1990s-current: Salmonellosis

- Cereal (1998, 2008)
- Chocolate (2001-02, 06, 15?)
- Flour (2008)
- Meal replacement powder (2014, 2016)
- Peanut/nut butters (1996, 2006, 09, 12, 14)
- Pet food/pet treats (dry)
- Seasoning: "Veggie Bootie" snackfood (2007)
- Seeds (hemp – 2011; chia 2014; chickpea 2014)
- Sesame (halva 2001; tahini 02, 03, 11, 12, 13)
- Tea (anise seed, fennel seed) (2002, 07)

Not just Salmonella

- Enterohemorrhagic E. coli gastroenteritis
  - E. coli O157:H7
    - Raw cookie dough (2009, U.S.)
      - Flour suspected as the source
    - Rice cake (2011, Japan)
      - Contamination during manufacturing most likely
    - Inshell hazelnuts (2011, U.S./Canada)
  - E. coli O121 and O26
    - Flour (2016, U.S.)

2001-current: salmonellosis in tree nuts

- Almonds – raw (U.S.)
  - 2000-01, Canada/U.S.
- Almonds - raw (Australia)
  - 2012, Australia
- Pine nuts - raw (Turkey)
  - 2011, U.S.
- Pistachios - raw and roasted? (U.S.)
  - 2009 (1 case), 2013, 2016 U.S.

Pathogens don’t grow in low-moisture foods

Pathogens survive well in low-moisture foods and low-moisture environments
How many undetected outbreaks?

- Geographically disperse
- Temporally separated
- Smaller number of unclustered cases
- Common strain or serovar
- Contaminated ingredient

Advances in Detection Methodology and Epidemiology

Wheat Flour, 2016, U.S.

- 63 cases
- 24 states
- 10 months

E. coli O121 and O26

8 months

Problems isolating pathogens from LMF:
Levels of pathogens

- Mean level of Salmonella: $13 \pm 14$ MPN/1000 g
- 2001 outbreak: est 1,200 MPN/1000 g (~1 MPN/g)

Lambertini et al., 2012. Food Research International, 45:1166-1174 and unpublished
Salmonella – infectious dose

Outbreaks – route cause

- Where information is available:
  - Contamination can occur before, during, or after harvest

Outbreaks – reoccurring themes

- WATER
  - Inadvertent introduction
  - Poor traffic flow
  - Wet sanitation procedures
    - Inadequate follow up

- DUST
  - Poor traffic flow
  - Construction

Surface that remain wet = harborage
Organic matter = growth potential
Salmonella and other pathogens are often MORE RESISTANT to processes by orders of magnitude when in or on low water activity foods.
Summary

- Risks of foodborne illness with low moisture foods
  - Low but measurable
  - Enhanced detection capabilities and surveillance
    - Will lead to increased outbreak identification
- Outbreaks often result of multiple breakdowns in GMPs
- Challenges
  - Low sporadic prevalence and low levels
  - Long-term survival
  - Enhanced resistance of pathogens
  - Cleaning/sanitation – water an issue
- Opportunities:
  - Significant multidisciplinary research in past decade
  - Awareness of issues leading to better control of these risks