Food Safety Across the Supply Chain – Keeping Your Foot on the Gas

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Foodborne Outbreaks Linked to U.S. Grown Tree Nuts

Salmonella
E. coli O157:H7

Dashed lines = weaker epidemiology
Foodborne Outbreaks Linked to California Grown Almonds

Salmonella

Dashed lines = weaker epidemiology

Salmonella Enteritidis Phage Type 30
Salmonella Enteritidis Phage Type 30

2001 outbreak investigation

Retail
Raw
Almonds
Handler
Huller/
Sheller
Grower

2001 15 of 32 - 150 acre orchards positive SEPT30- 10 sq miles

Origin of Salmonella Enteritidis PT 30 never identified

The hunt for Salmonella Enteritidis Phage Type 30
Salmonella Enteritidis Phage Type 30

Harris Lab  UCD Lab  USDA Lab
San Bernardino  Nebraska

Foodborne Outbreaks Linked to California Grown Almonds

September 1, 2007
Implement Mandatory Treatment Process
4-log reduction of Salmonella
7 CFR Part 981.442b
Why
4 log (100,000-fold) reduction?
Prevalence of *Salmonella* in 100-g Raw Almond Kernels With 95% CI

Levels of *Salmonella* in almonds per 100 g

Total 14,949 samples

Average ~1% positive

Total 109 positive samples

Average – 1.3 ± 1.4 MPN/100 g

Prevalence of *Salmonella* in 100-g Raw Almond Kernels With 95% CI

Total 14,949 samples

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Average – 1.3 ± 1.4 MPN/100 g
1% Prevalence of *Salmonella* in 100-g Raw Almond Kernels

Based on 14,949 samples over 9 years

\[ \sim 15,000 \times 100 = 1,500,000 \text{ g} = 3,300 \text{ lbs} = \text{total amount sampled} \]

\[ \sim 10,600,000,000 \text{ lbs produced in those 9 years} \]

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Monte Carlo Simulations Assessing the Risk of *Salmonellosis* from Consumption of Almonds

MICHELLE D. DANYLUK,† LINDA J. HARRIS,‡ AND DONALD W. SCHAFFNER§

First Risk Assessment

Helped Almond Board Management Decision to set

4-log reduction of *Salmonella* in almonds

7 CFR 981.442(b)

Note: log = logarithm
Risk of salmonellosis from consumption of almonds in the North American market
Elisabetta Lamberti \textsuperscript{a}, Michelle D. Danylik \textsuperscript{b}, Donald W. Schaffner \textsuperscript{c}, Carl K. Winter \textsuperscript{a}, Linda J. Harris \textsuperscript{a,*}

Second Risk Assessment
- Used updated data (reduced uncertainty)
- Evaluated "state of the industry"
- Evaluated ABC "pasteurization" program
- Evaluated "limits" where program might fail
- Evaluated 2000/2001 outbreak data

Why/When?

Levels of \textit{Salmonella} in almonds per 100 g

Average – 1.3 ± 1.4 MPN/100 g
2001 Outbreak
Est. up to 120 cells/100 g

Salmonella serovars isolated
2001-07, 2010, and 2013

- Multiple PFGE patterns for repeat serovars
Whole Genome Sequence Analysis

- 171 isolates from almond kernels
- 9 year survey, ~15,000 samples
- Wide range of *Salmonella* types
- 39 serovars
- 22 serovars isolated single times

Hypothesis: Contamination Source

- Evidence suggests under normal circumstances contamination on the farm is:
  - Environmental
  - Sporadic
  - Random
  - Low levels
Why does the same serovar sometimes show up in replicate but independent samples?

Guidance for Industry: Enforcement Policy for Entities Growing, Harvesting, Packing, or Holding Hops, Wine Grapes, Pulse Crops, and Almonds
“We will consider revising our intent to exercise enforcement discretion if, for example, new information becomes available regarding safety concerns associated with the production and consumption of these commodities.”

7 CFR Part 981.442b – Validation September 2007

Goal is to demonstrate ability to achieve a minimum 4-log reduction (100,000-fold reduction) of *Salmonella* on almonds

Based on survey data of ~1% prevalence and low numbers
Produce Safety Rule
Enforcement Discretion

Assumes Almond Growers Follow GAPs

AND

Almond Huller/Shellers Follow GMPs

Harris opinion

IF there is another California almond outbreak - the cause will be:

1) Unusually high contamination of a lot during production or harvest
   ◦ Contamination exceeds the capacity of a 4-log treatment
   ◦ Should be addressed in grower food safety plan
   ◦ Should be addressed in huller/sheller GMP program

2) Consumption of raw product (sold outside of North America)
   ◦ Should be addressed in grower food safety plan
   ◦ Should be addressed in handler food safety plan
   ◦ Should be addressed by treatment at final destination

3) Recontamination of adequately treated product
   ◦ Handler cross contamination
   ◦ Should be addressed in handler food safety plan
Avoiding High Level Contamination at the Farm Is Important

Shell is not protective in soft shell varieties

Increases in *Salmonella* are possible when almond hulls are wet

Assessing Risks Unique to Almonds

Almonds dry on the ground for 7 to 10 days

The orchard floor serves as a “food contact surface”
Assessing Risks Unique to Almonds

Rain Event

Premature drops and sprinkler

Almond Board of California “Stockpile Management Best Practices”
2001 to 2019

- How many more growers?
- How many more acres?
- How many more pounds?

How many understand and appreciate the basis of the current food safety practices?

2 ml 3 ml 4 ml 0 ml

Salmonella Grows in Wet Almond Dust

Du et al., 2010. J. Food Sci. M7-13
Post Harvest Treatment Options

- **Wet Heat**: Steam, Water, Humidity, Re-wetting, Vacuum
- **Dry Heat**: Convection, Baking, Roasting, Infrared, radio frequency
- **Nonthermal**: Radiation, Plasma, High pressure, Propylene or Ethylene Oxide, Ozone
- **Gas**: Peracetic acid
- **Other Chemical**: Ozone

What happens as we get better at hitting a target minimum 4-log reduction?

- Log Reduction
- Time
- Upper Control Limit
- Lower Control Limit
- Average
- 7 → 6
- 5.5 → 5
- 4 → 4
The Salmonella Control Equation

TRAFFIC CONTROL (PERSONNEL & EQUIPMENT) + DUST CONTROL + WATER CONTROL + SEPARATION OF RAW & PASTEURIZED PRODUCT + EFFECTIVE CLEANING & SANITATION

SALMONELLA CONTROL

Effective Pathogen Environmental Monitoring

pathogen environmental monitoring program (PEM)

http://www.almonds.com/processors/processing-safe-product#pem
EVERYONE PLAYS A ROLE IN FOOD SAFETY

Grower

Huller/Sheller

Handler

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Predicting the future?

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Salmonella

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