Almond Food Safety: Past, Present and Future
Session Speakers

Tim Birmingham, ABC
Brian Dunning, Shoei Foods
Linda Harris, UC Davis
Almond Food Safety: Past, Present, and Future

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FOOD SAFETY

PAST   PRESENT   FUTURE

2001   2019
2001 almond outbreak: Onset Dates of *Salmonella* Enteritidis PT30 Cases Canada/Raw Almond Shipments from California


Long shelf life, long-term survival
Outbreaks can spread over many months

Initial Recall
April 12, 2001

Estimated time
almonds in store

Harvest 09 and 10, 2000

Weekly
176,500 lbs Total

Weekly
120,000 lbs Total
Consumer Trends – 2001

Raw Almonds
Out-of-hand consumption
Increased volume

Outbreak Investigation Trends – 2001

*Salmonella* Phage Typing **

PFGE
Isolation of *Salmonella* Enteritidis Phage Type 30

2001 outbreak investigation

- Retail Raw Almonds
- Handler
- Huller/Sheller
- Grower
100% of 54 isolates from 230 pooled swabs from 2001-2006 were *Salmonella Enteritidis* PT 30.
All isolates have less than 3 SNPs difference with the 2001 outbreak isolate.

TRANSLATION: They are the same strain.
Prevalence of *Salmonella* in 100-g Raw Almond Kernels With 95% CI

- **Total 14,949 samples**
- **Average ~1% positive**

Levels of *Salmonella* in almonds per 100 g

- **Total 109 positive samples**
- **Average – 1.3 ± 1.4 MPN/100 g**
Salmonella serovars isolated 2001-07, 2010, and 2013

- Multiple PFGE patterns for repeat serovars

<table>
<thead>
<tr>
<th>Salmonella Montevideo</th>
<th>Year isolated</th>
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<tbody>
<tr>
<td></td>
<td>04, 06 (2)</td>
</tr>
<tr>
<td></td>
<td>02, 05</td>
</tr>
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<td>01, 03, 05</td>
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</tbody>
</table>
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

*Salmonella* serovars isolated 2001-07, 2010, and 2013
Hypothesis: Contamination Source

- Evidence suggests under normal circumstances contamination on the farm is:
  - Environmental
  - Sporadic
  - Random
  - Low levels
Maximum likelihood tree based on SNPs identified in *Salmonella* Enteritidis genomes within the FDA CFSAN pipeline.
Source Attribution of *Salmonella* in Macadamia Nuts to Animal and Environmental Reservoirs in Queensland, Australia

Nanna Munck,¹ James Smith,² John Bates,³ Kathryn Glass,⁴ Tine Hald,¹ and Martyn D. Kirk⁴
Agricultural Water Quality
Produce Safety Rule
Combined Almond Inoculations (Inoculation Days 7-22-2019, 8-12-2019)

Day 0 (7-22) Hull Condition: **12% Not Split, 72% Some Signs of Splitting, 16% Split**
Weight 10-20 g

Day 0 (7-12) Hull Condition: **100% Split and Brown**
Weight 3-7 g
Changes in Harvest Practices – What Impact?
Inhull - Growth of *Salmonella* at 37°C/98°F

Data funded, in part, by Pistachio Research Board

No growth within 3 h at 37°C/98°F
Or 4 to 7 h at 23°C/75°F
Temperature at Receipt and Wait Time

\[ y = -0.4129x + 17667 \]
\[ R^2 = 0.1167 \]

\[ y = 0.0743x - 3164 \]
\[ R^2 = 0.1162 \]
Company or Vendor Consultation with ABC and Process Authority on equipment

Process authority validation studies

ABC staff (and TERP) support & review

TERP review & determination

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 and thousands of other data points
Risk of salmonellosis from consumption of almonds in the North American market

Elisabetta Lambertini a, Michelle D. Danyluk b, Donald W. Schaffner c, Carl K. Winter a, Linda J. Harris 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
Is *Salmonella* the pathogen of concern in almonds?

Survival of *Salmonella*, *E. coli* O157:H7, and *L. monocytogenes* on stored almonds (ambient temperature)

![Graph showing survival of Salmonella, E. coli O157:H7, and L. monocytogenes on stored almonds](image)

23°C/73°F

Kimber et al., 2012
Reduction of *E. coli* O157:H7, *Listeria monocytogenes* and *Salmonella Enteritidis* PT30 on almonds: oil at 250°F

![Graph showing the reduction of *E. coli*, *Listeria monocytogenes*, and *Salmonella Enteritidis* PT30 on almonds with treatment time (min). The x-axis represents treatment time (min) and the y-axis represents Log N/N0. The graph shows that the log reduction of these bacteria increases with treatment time.]
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,
- ??

Gas
- Propylene or
- Ethylene
- Oxide,
- Ozone

Other Chemical
- Peracetic acid
- ??
What happens as we get better at hitting a target 4-log reduction?
PROCESS VALIDATION GUIDELINES

PAST  PRESENT  FUTURE

2006  2019

UPDATE?
CONSUMER TRENDS

“Enhanced Nut”
“Fermented”
“Sprouted”

“RAW ECSTASY”
Soaking, Activating, Sprouting – Big on Blog Sites and the Media

Is Soaking Nuts Necessary & How to Properly Soak Your Organic Raw Nuts!

Why Soaked Almonds are Better Than Raw Almonds

Health Benefits of Soaking Almonds in Water Before Eating

13 Surprising Benefits Of Almonds Nutrition
Hundreds of How-To Videos

- How to soak almonds
- Reasons You Should Have Soaked Almonds
- Almonds - Soaking, fermenting, flour and butter
- Are soaked almonds better to eat?
- Soaking Almonds, Nuts and Seeds To Improve Nutrient Uptake and
- Enzymes, Almonds & Soaking
- HOW TO SOAK ALMONDS pt. 1 of 3
- Soak 12 ALMONDS IN WATER OVERNIGHT AND EAT IT NEXT
- Benefits of Soaking Almonds in Water
- 6 Reasons to Soak Almonds Before Eating Them
- The Benefits of Soaking Almonds and Vegan Almond Mayo!
- Burn Fat and Balance Your Blood Sugar with Soaked Almonds for
- SOAK 4 ALMONDS IN WATER OVERNIGHT AND EAT IT NEXT
- Why You Should Always Soak Almonds Before Eating Them
- HOW TO SOAK NUTS AND SEEDS ~ VIDEO TUTORIAL
Google Trends Search Interest “Soaking Almonds”

Data were retrieved from https://trends.google.com/ on November 6, 2019.
Commercial Products Increasingly Available
Can pathogens grow in soaked almonds?

**Moisture content:**
- 5.7 ± 0.3%
- 40 ± 0.5%

**Microorganisms in control**
- **Salmonella**
- **L. monocytogenes**

**Log CFU/sample vs. Time (h)**

**Moisture content:**
- 5.3 ± 0.1%
- 40 ± 0.9%

**E. coli O157:H7**
Will pathogens grow at lower temperatures?

Inoculated almonds soaked at different temperatures for 24 h

<table>
<thead>
<tr>
<th></th>
<th>0 h</th>
<th>15°C</th>
<th>18°C</th>
<th>23°C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E. coli O157:H7</strong></td>
<td>(blank)</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td><strong>L. monocytogenes</strong></td>
<td>(blank)</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td><strong>Salmonella</strong></td>
<td>(blank)</td>
<td>4</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

Storage time and temperature
Does *Salmonella* die when drying soaked almonds?

*Salmonella* on inoculated almonds soaked in sterile ultrapure water for 24 h then dried.
EVERYONE PLAYS A ROLE IN FOOD SAFETY
Salmonella Foodborne Outbreaks Linked to California Grown Almonds

- September 1, 2007
- Implement Mandatory Treatment Process
- 4-log reduction of *Salmonella*
- 7 CFR Part 981.442b

Dashed lines = weaker epidemiology
Remaining vigilant

Continually assessing trends across the supply chain and potential food safety risks
Almond Food Safety: Past, Present and Future
Upcoming Sessions at 2:15 p.m.

- Sterile Insect Control of Navel Orangeworm (Room 1)
- India: Strong Today, Stronger Tomorrow (Room 2)
- Could Cover Crops or Whole Orchard Recycling Help with Orchard Management? (Room 3)
Visit the Exhibit Halls and Participate in the Passport Game

- 3P Partners #2206
- ABC Booth #526
- AC Horn #421
- Ag Spray Equipment #2203
- Bayer CropScience #127
- Best Drayage #2112
- Bird Gard, LLC #1812
- Borrell USA #327
- Cablevey Conveyors #217
- Central Life Sciences #917
- JAX, Inc. #413
- JKB Energy #635
- K·Coe Isom #707
- Lincoln Agribusiness Services #733
- Napasol #2205
- NETZSCH Premier Technologies #218
- Satake #521
- Suterra, LLC #1638
- TOMRA Sorting Solutions #335
- Tréé, Inc #516
- Valent U.S.A. #621
- Westbridge Agricultural Products #1534
- Wilkey Industries #320
- Yara North America #627

The first 500 attendees to turn in a completed passport card to the ABC booth (#526) will receive a hat and will be entered to win one of seven amazing prizes!
Lunch: Pushing Your Personal Limits
Featuring John Stenderup

Doors open at 12:15 p.m. in Building C
You must have already purchased a ticket to attend luncheon

Sponsored by:

FARM CREDIT
Food Truck Village

Food Truck Village is located next to Building D

Open on Tuesday and Wednesday from 11:00 a.m. – 2:30 p.m.

Cash and credit cards are accepted
Shuttle Schedule

Shuttle service will be provided by The Almond Conference from the downtown hotels to Cal Expo daily.

- Downtown Pickup Location: Hyatt Sacramento Front Drive
- Cal Expo Pickup and Drop-Off Location: Blue Gate

Shuttle Schedule:

- Tuesday, Dec. 10
  - 6:45 a.m. – 6:30 p.m.
- Wednesday, Dec. 11
  - 6:45 a.m. – 6:30 p.m.
- Thursday, Dec. 12
  - 6:45 a.m. – 1:30 p.m.
2019 Research Update

Pick up a copy at the ABC booth #526
Join the Conversation!

Use #AlmondConf to share highlights from The Almond Conference
Dedicated Trade Show Time
4:30 p.m. – 6:00 p.m.

Social Reception Sponsored by:
Join Tonight’s Social Reception

Come and Sample:
ALMOND BROWN ALE

Stop by:
The Almond Board Lounge in Building D.

Sample:
Almond brown ale during the Tuesday and Wednesday receptions.

This almond beverage is the result of a special project from Dominique Camou and Lucas Schmidt in collaboration with Temblor Brewing Company.

Industry members and attendees are welcome to stop by and have a taste.

When:
Tuesday and Wednesday evening reception from 4:30-6:00 p.m.

4:30 p.m. – 6:00 p.m. - Pavilion + Building D
10 YEARS OF PROGRESS

JOIN THE JOURNEY

It's all there at SustainableAlmondGrowing.org
Thank you!