

What can the almond industry learn from recent outbreaks of *E. coli* gastroenteritis in flour and nut butters?



LINDA J. HARRIS, PHD
SPECIALIST IN COOPERATIVE EXTENSION
CHAIR
DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY,
UNIVERSITY OF CALIFORNIA, DAVIS

UCDAVIS
FOOD SCIENCE AND
TECHNOLOGY

(LJHARRIS@UCDAVIS.EDU) JUNE 22, 2017



Outline

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- Overview of foodborne illnesses with low moisture foods
- Recalls
- Outbreaks
- What do we know in almonds
 - Prevalence
 - Survival during storage
 - Desiccation tolerance
 - Thermal tolerance

Salmonella - salmonellosis

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- Infectious dose
 - Low (dependent)
- Incubation period
 - 12 to 72 hours
- Symptoms
 - Diarrhea, fever, abdominal cramps, vomiting
 - Death can occur with infants and elderly/sick
- Duration
 - 4 to 7 days
- Long-term impacts
 - Reactive arthritis

Listeria monocytogenes (LM) - listeriosis (one type of illness)

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- Infectious dose
 - Maybe thousands, dependent
- Incubation period
 - 3 to 70 days
- Symptoms
 - Fever, stiff neck, confusion, weakness, vomiting, sometimes preceded by diarrhea
 - Death can occur (pregnant women loose baby), elderly, weakened immune systems
- Duration
 - Days to weeks
- Long-term impacts
 - A *Listeria* infection can lead to meningitis, an inflammation of the membranes surrounding the brain

Enterohemorrhagic *E. coli* gastroenteritis - (EHEC or STEC)

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- Infectious dose
 - Low (dependent)
- Incubation period
 - 1 to 10 days
- Symptoms
 - Severe diarrhea, often bloody, severe abdominal pain, vomiting
 - Hemolytic uremic syndrome (HUS) – 5 to 10%
 - Toxins destroy red blood cells and damage kidneys
 - Death can occur with young children and elderly
- Duration
 - 5 to 10 days
 - HUS can happen after a week
- Long-term impacts
 - HUS can lead to severe outcomes including need for kidney transplant, multi-organ damage

Hazard Analysis

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- Must be written
 - Prepared or preparation overseen by qualified individual
- Must identify and evaluate:
 - known or reasonably foreseeable hazards for each type of food
 - Based on experience, illness data, scientific reports, and other information
- Determine whether there are any hazards requiring a preventive control.

HACCP



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Severity and probability in the absence of preventive controls



		Severity		
		Low	Medium	High
Likelihood	High		PC	PC
	Medium	GMP		PC
	Low	GMP	GMP	

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Assessing Hazards



Recalls U.S.

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- *Salmonella*
 - almonds (2001, 04), cashew (2014, 15), hazelnuts (2009, 13), macadamia (2009, 10, 12, 14, 15), pecans (2009, 10, 14, 15), pine nut (2011, 15), inshell pistachios (2009,13), walnut (2014, 15)
- *E. coli* O157:H7
 - hazelnuts (2011), walnuts (2011)
- *Listeria monocytogenes*
 - Peanut butter (2014), walnuts (2009, 13), sunflower (2016)
 - Mixed products with almonds (2017)



Palumbo, M., L. R. Beuchat, M. D. Danyluk, and L. J. Harris. 2017. Recalls of tree nuts and peanuts in the U.S., 2001 to present [Table and references]. *In* U.S. recalls of nuts. Available at: http://ucfoodsafety.ucdavis.edu/Nuts_and_Nut_Pastes.

Salmonellosis – tree nuts

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- Almonds – raw (U.S. source)
 - 2000-01, Canada/U.S.
 - 2003-04, U.S./Canada
 - 2006, Sweden
- Almonds - raw (Australia source)
 - 2012, Australia
- Hazelnuts (inshell, U.S.)
 - 2016
- Pine nuts - raw (Turkey)
 - 2011, U.S.
- Pistachios - raw and roasted? (U.S.)
 - 2009 (1 case), 2013, 2016



Salmonellosis

Nut butters and other products

- Peanuts
 - 94-95, 01, 06 (boiled – GA), 10
- Cashew cheese – raw (SE Asia)
 - 2013, U.S.
- Peanut butter
 - 1996 (Australia)
 - 2006-07*, 09*, 12, 14 (U.S. source)
- Peanut/almond butter
 - 2014 (U.S.)
- Sprouted tree nut spreads
 - 2015 (U.S.)



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Enterohemorrhagic *E. coli* O157:H7 gastroenteritis

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- ▶ Inshell hazelnuts (U.S.)
 - 2011, US/Canada
- ▶ Walnuts – raw (U.S.)
 - 2011, Canada (linked)



Harris, L. J., M. Palumbo, L. R. Beuchat, and M. D. Danyluk. 2017. Outbreaks of foodborne illness associated with the consumption of tree nuts, peanuts, and sesame seeds [Table and references]. In *Outbreaks from tree nuts, peanuts, and sesame seeds*. Available at: http://ucfoodsafety.ucdavis.edu/Nuts_and_Nut_Pastes.

Enterohemorrhagic *E. coli* O157:H7 gastroenteritis

- Rice cake (2011, Japan)
 - Contamination during manufacturing most likely



Enterohemorrhagic *E. coli* O157:H7 gastroenteritis

- Soy nut butter (2017, U.S.)
 - Contamination at co-packer (Dixie Dew) suspected
 - Registration suspended March 27 at Dixie Dew
 - 483 inspection report – must read
 - 32 cases 12 states
 - 12 people hospitalized, 9 HUS
 - 26 under 18 years old



I.M. Healthy Bankrupt

To find 483 Google: "Dixie Dew 483 FDA"

To find suspension Google: "Dixie Dew Suspension FDA"



Flour



- 2008-2009 New Zealand
 - *Salmonella* Typhimurium
 - 67 cases
- 2009 U.S., 31 states
 - Enterohemorrhagic *E. coli* O157:H7 gastroenteritis
 - 80 cases, raw cookie dough (flour implicated)
- 2015 – 2016 U.S., 24 states
 - Enterohemorrhagic *E. coli* O121/O26 gastroenteritis
 - 63 cases
- 2016 – 2017 AND 2017 Canada
 - Enterohemorrhagic *E. coli* O121 gastroenteritis
 - 30 AND 6 cases

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Special case: seed sprouts

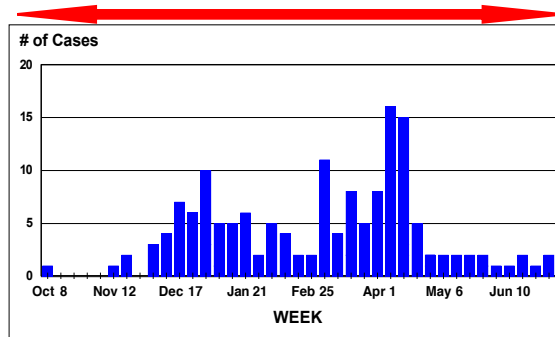
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- Numerous significant outbreaks worldwide early 1990s to present
 - *Salmonella*, *E. coli* O157:H7, *E. coli* O104:H4
- Sprouted seeds are high moisture food
 - Source: **the seed**
 - e.g., alfalfa, clover, fenugreek, radish
 - "Chia" – 2014 (also flour)
- **Extended pathogen survival in the low-moisture seeds**
- Sprouting enriches for the pathogen

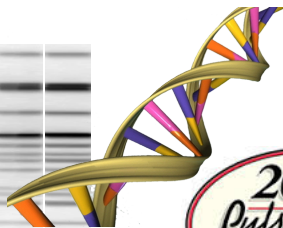
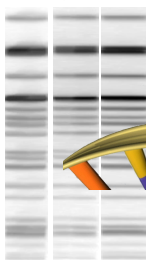


How many undetected outbreaks? ¹⁷

- Common serovar of *Salmonella*
- Smaller number of unclustered cases
- Geographically disperse
- Temporally separated
- Contaminated ingredient



Advances in Detection Methodology



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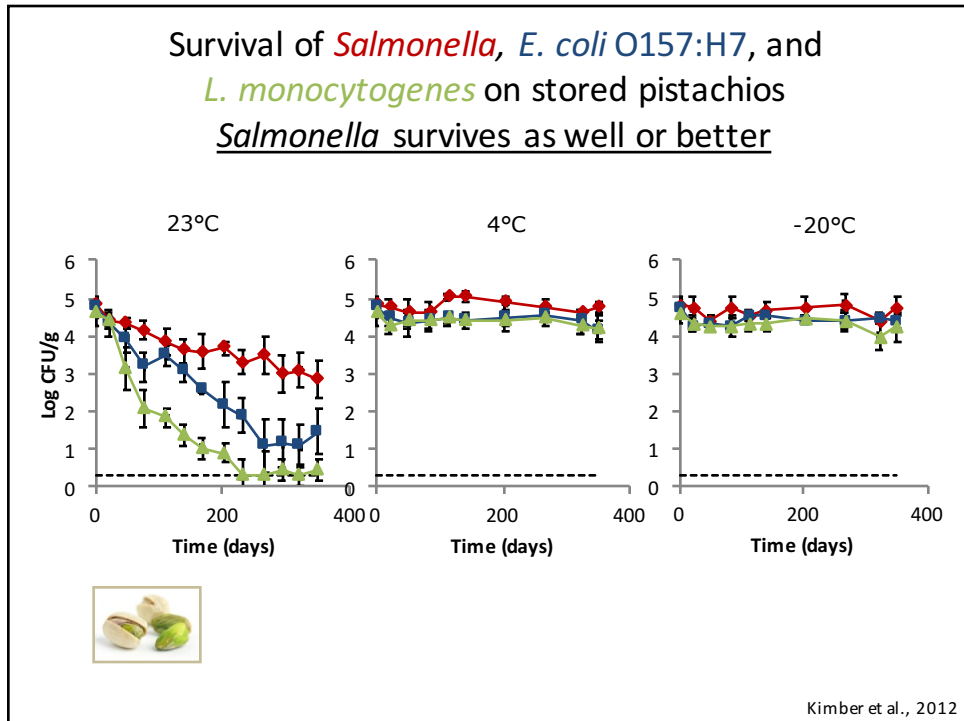
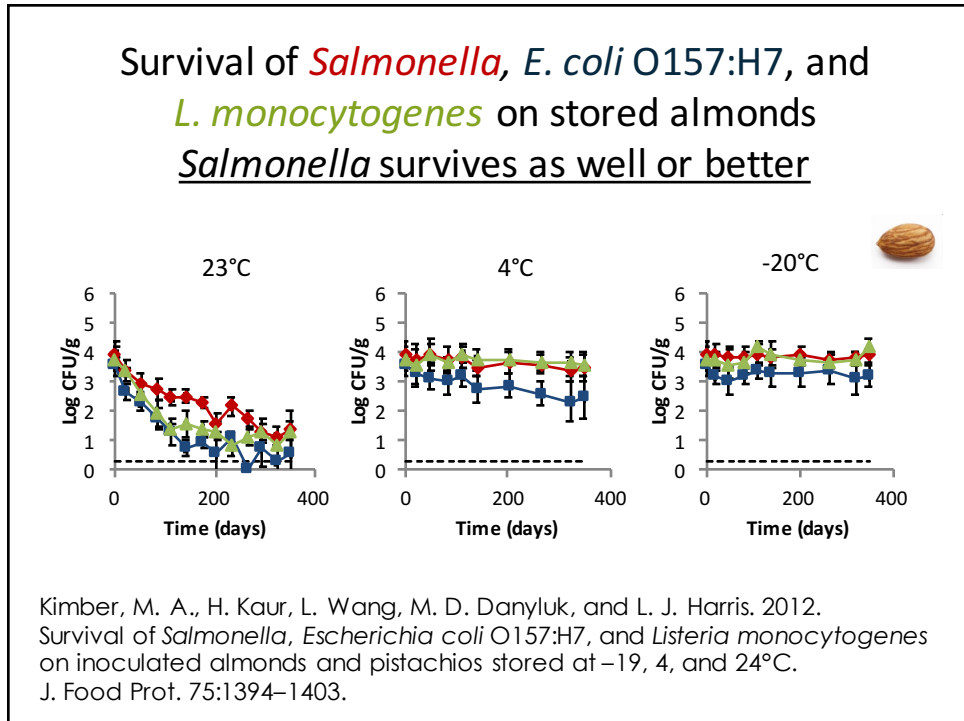
What do we know?

E. coli O157:H7 – survey data

- California Almonds 2013
 - 977 samples of 375 g
 - **NONE POSITIVE**
 - Unpublished
- California Inshell Walnuts 2011, 2012, 2013
 - 3,839 samples of 375 g
 - **NONE POSITIVE**
 - Davidson et al., 2015



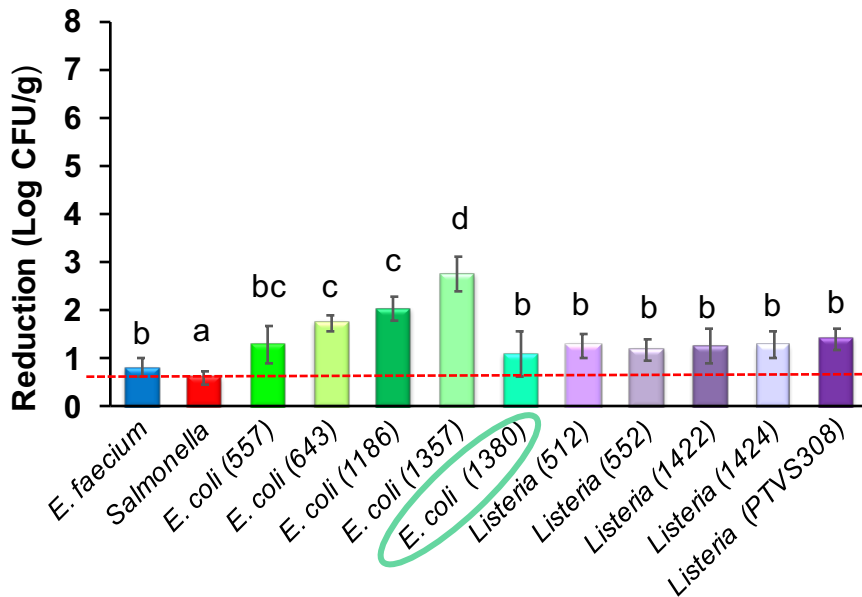
Davidson, G.R., J. C. Frelka, M. Yang, T. M. Jones, and L. J. Harris. 2015. Prevalence of *Escherichia coli* O157:H7 and *Salmonella* on inshell California walnuts. *J. Food Prot.* 78(8):1547–1553. Available from Harris.

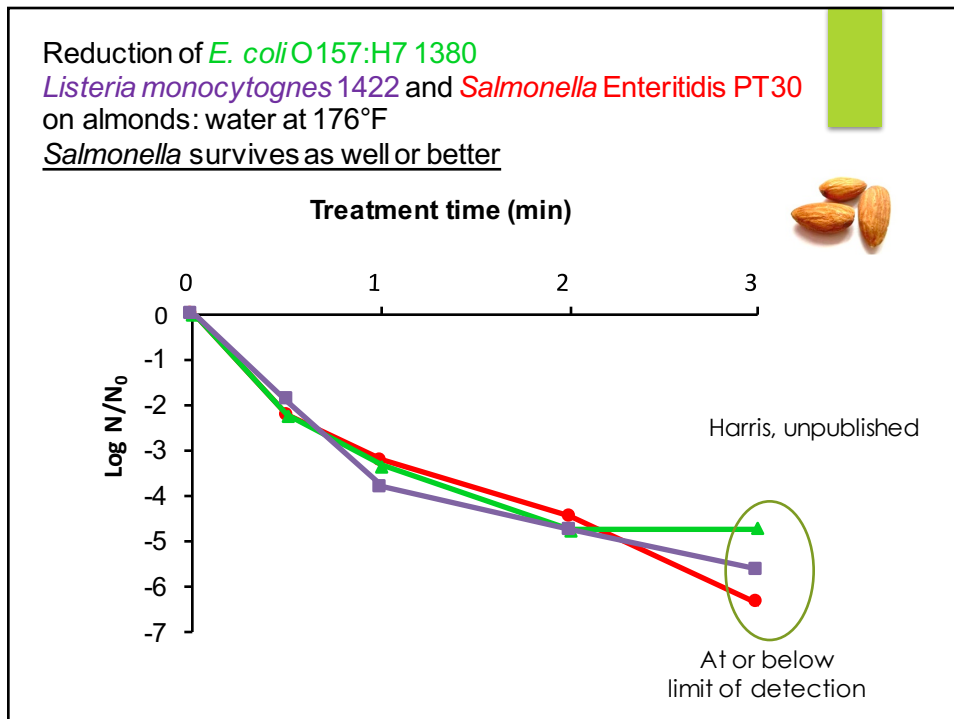
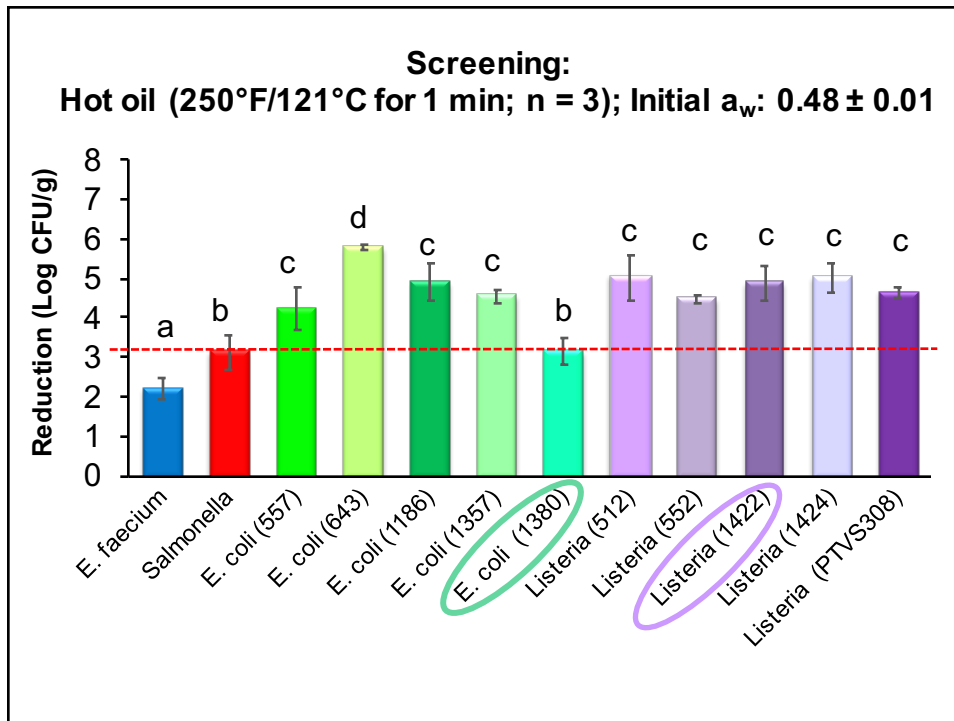


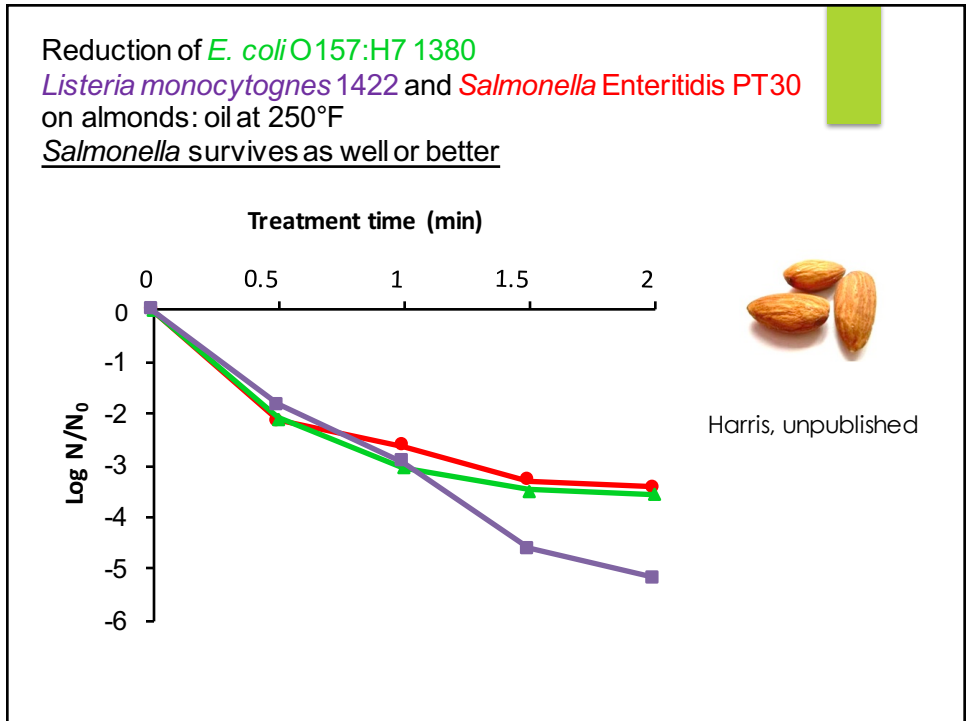
E. coli O157:H7 and *L. monocytogenes* Isolates used in thermal resistance studies

Strain	Comment
<i>Enterococcus faecium</i> NRRL 2354	Surrogate for Process Validation
<i>Salmonella</i> Enteritidis PT 30	2001 Raw Almond Outbreak
<i>E. coli</i> O157:H7 LJH557	Apple cider outbreak, clinical
<i>E. coli</i> O157:H7 LJH643	Cantaloupe outbreak, clinical
<i>E. coli</i> O157:H7 LJH1186	Spinach outbreak, clinical
<i>E. coli</i> O157:H7 LJH1357	Cookie dough outbreak, food isolate
<i>E. coli</i> O157:H7 PT 4 LJH1380	Walnut outbreak, clinical
<i>L. monocytogenes</i> (4b) LJH512	Cabbage outbreak, food isolate
<i>L. monocytogenes</i> (4b) LJH552	Tomatoes
<i>L. monocytogenes</i> LJH1422	Raw diced yellow onions, recall
<i>L. monocytogenes</i> LJH1424	Celery processing facility
<i>L. monocytogenes</i> PTVS 308	Cantaloupe outbreak, food isolate

**Post-inoculation drying and equilibration
(3 days at 23°C + 2 days at 45% RH and 25°C)**







Resources

www.ucfoodsafety.ucdavis.edu/Low_Moisture_Foods/

University of California
 UC Food Safety

Low Moisture Foods

Grocery Manufacturer's Association (GMA)

The grocery manufacturer's association plays an active role in developing and promoting comprehensive food safety initiatives for the food industry and provides support to the industry with regard to compliance with federal, state and local regulations. The following documents were generated in partnership with the food industry.

- [Facility Design Checklist \(will open as MS Excel spreadsheet.\)](#)
- [GMA Equipment Design Checklist for Low Moisture Foods \(will open as MS Excel spreadsheet.\)](#)
- [Salmonella Control Guidance \(PDF 540 KB\)](#)
- [Annex to Salmonella Guidance \(PDF 203 KB\)](#)
- [Technical Guidance and Tools](#)
- [Guidelines for Validation of Consumer Cooking Instructions for Not-Ready-to-Eat \(N RTE\) Products](#)

Cereals and Grains

Resources

www.ucfoodsafety.ucdavis.edu/Nuts_and_Nut_Pastes/

University of California, Division of Agriculture and Natural Resources

UC Food Safety



Home Better Process Control Schools Consumers Food Safety Links Pre- & Post-harvest Produce Food Service/Retail Food Processing

Food Industry Contacts UC Publications Contact Us Upcoming Training

Nuts and Nut Pastes

Food safety information for nuts and nut products.

General Food Safety Information

- Bibliography: Containing a comprehensive list of references pertaining to microbial safety of nuts and sesame seed. [Publications on the Microbial Safety of Nuts and Sesame Seeds \(updated 2-6-17\) \(PDF 214 KB\)](#)
- [GMA Equipment Design Checklist for Low Moisture Foods \(2-9-10\) \(will open as MS Excel spreadsheet.\)](#)
- [Inactivation of Microorganisms in Nuts and Nut Pastes: Table and References \(updated 2-6-17\) \(PDF 91 KB\)](#)
- [Outbreaks from Tree Nuts, Peanuts, and Sesame Seeds \(updated 6-9-17\) \(PDF 84 KB\)](#)
- [Reportable Food Registry Annual Report \(FDA\) May 2016](#)
- [Surveys for Foodborne Pathogens on Nuts: Tables and References \(updated 6-9-17\) \(PDF 111 KB\)](#)
- [Survival of Foodborne Pathogens on Nuts: Tables and References \(updated 4-10-17\) \(PDF 85 KB\)](#)
- [U.S. Recalls of Nuts: Table and References \(updated 6-9-17\) \(PDF 107 KB\)](#)

Summary

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- Foodborne illness in low moisture foods
 - Dominated by *Salmonella*
 - Increasingly associated with EHEC/STEC
 - Recalls associated with *L. monocytogenes*
- In almonds
 - Prevalence of *E. coli* O157:H7 appears to be low
 - *E. coli* O157:H7 and *L. monocytogenes*
 - Survival appears to be less than *Salmonella*
 - Thermal tolerance appears to be no more than *Salmonella*
- Copy of 2015 IAFF poster will be made available through ABC

