



***Listeria monocytogenes* Produce Safety Issue Brief July 2017**

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Background

In recent years there have been a number of high profile foodborne illness outbreaks and product recalls due to Lm contamination of fresh produce (see details below regarding outbreaks and recalls). These produce associated Lm foodborne illness outbreaks and recalls have brought to the forefront many uncertainties regarding the public health risks associated with Lm and fresh produce such as Lm prevalence rates, Lm contamination levels and Lm growth rates on fresh produce. These incidents will likely increase the frequency of testing fresh produce items by individual companies and regulatory agencies, and the use of whole genome sequencing, “case matching” to contaminated food items will likely lead to an increased frequency of reported outbreaks of listeriosis linked to fresh produce items. However, it will not be clear if increased testing alone or an actual change in the risks associated with fresh produce consumption has occurred.

The public health burden of listeriosis has historically been associated with infrequent occurrence in food items contaminated with relatively high levels of Lm. However, the recent reported deaths associated with consumption of Blue Bell ice cream are of particular concern in that low levels of Lm were reported in frozen ice cream which is considered an Lm non-growth food during frozen storage conditions.

Historically, particular attention has been given to persistent populations of Lm in food processing plant environments that may lead to high levels of contamination of food products. However, most fresh produce contamination likely results from occasional transient contamination of raw agricultural commodities from natural environments in low numbers. This type of contamination may or may not represent an elevated public health risk. The challenge for the produce industry and regulatory agencies is to distinguish between intermittent, low-level contamination and persistent environmental contamination of processing environments that may result in substantial numbers of illnesses. Preventive control strategies that focus on identifying and controlling persistent sources of environmental Lm contamination are likely to maximize public health outcomes by preventing disease without frequently alarming the public about the safety of fresh produce.

Facts Regarding *Listeria monocytogenes*

Excerpted: FDA Bad Bug Book Foodborne Pathogenic Microorganisms & Natural Toxins, 2012, CDC, and other cited sources.

<http://www.fda.gov/Food/FoodborneIllnessContaminants/CausesOfIllnessBadBugBook/>

<https://www.cdc.gov/listeria/faq.html>

1. The Organism

Lm is a Gram-positive, rod-shaped, facultative bacterium, motile by means of flagella, that is among the leading causes of death from foodborne illness.

- **Serotypes:** Lm has 13 serotypes, including 1/2a, 1/2b, 1/2c, 3a, 3b, 3c, 4a, 4ab, 4b, 4c, 4d, 4e, and 7. Among them, serotypes 1/2a, 1/2b, and 4b have been associated with the vast majority of foodborne infections.
- **Lm is hardy**
 - Salt-tolerant
 - Can survive at temperatures below 1°C
 - Can grow at low temperature, unlike many other pathogens
 - Known to persistence in food-manufacturing environments
 - Commonly found in the environment particularly in moist environments, soil, and decaying vegetation
- **Other non-pathogenic *Listeria* species:** *L. grayi*, *L. innocua*, *L. ivanovii*, *L. seeligeri* and *L. welshimeri*

2. Listeriosis the Disease

- **Mortality:** Listeriosis and complication from listeriosis are among the leading causes of death from foodborne illness, with the severe invasive form of the infection having a case-fatality rate of 15% to 30%. Each year there are an estimated 1600 cases of illness; 1,455 hospitalizations, 255 deaths (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3375761/>)
- **Vulnerable Populations:** Pregnant women, fetus, persons with weak immune systems, (for example, those with AIDS or chronic diseases, or who are on certain immune suppressing arthritis drugs or cancer chemotherapy) and the elderly are especially vulnerable. It's rare for people in other groups to get sick with *Listeria* infection.
- **Two Forms of the Disease & Onset**
 - **Non-invasive gastrointestinal illness:** mild to intense symptoms of nausea, vomiting, aches, fever, and, sometimes, diarrhea with an illness onset of a few hours to 2-3 days. Generally self-resolves in otherwise healthy people. This form of illness is rare and only occurs when very high levels of Lm are consumed.
 - **Invasive form of the illness:** caused by infection spreading through the bloodstream to the nervous system (including the brain), resulting in meningitis and other potentially fatal problems. Pregnant women typically experience only fever and other flu-like symptoms, such as fatigue and muscle aches. However, infections during pregnancy can lead to miscarriage, stillbirth, premature delivery, or life-threatening infection of the newborn.
People other than pregnant women: Symptoms can include headache, stiff neck, confusion, loss of balance, and convulsions in addition to fever and muscle aches. This illness form can have a very long incubation period, estimated to vary from 3 days to 3 months.

- **Infective Dose:**

- The infective dose of Lm is undetermined, may vary widely and depends on a variety of factors.
- Believed to vary with the strain and susceptibility of the host and the food involved. For example, in cases associated with raw or inadequately pasteurized milk it is likely that fewer than 1,000 cells may cause disease in susceptible individuals.
- Pouillot et al, 2014 demonstrated through recent risk modeling analysis that: *“while most of the cases are linked to a medium and high exposure doses to Lm, those at greatest risk of developing listeriosis are also at a measurable risk of illness when consuming food contaminated with relatively low doses of Lm especially if highly virulent bacterial strains are involved.”*

3. Agricultural Prevalence:

- Chapin et al, 2014 reported that the prevalence of *Listeria species*, was found in approximately 33% of samples obtained from the natural environment (n= 734) and 34% of the time in samples obtained from produce production environs (n=734) in New York State. These data show that *Listeria species* were prevalent in both agricultural and non-agricultural environments.
- Strawn et al, 2013 reported that over 5 weeks when 21 farms in New York State were sampled, Lm was found in 17.5% of produce field soils or drag swab samples (n=263) and 30% of water samples (n=74). However, the majority of pathogen positive water samples were from non-irrigation surface water sources.

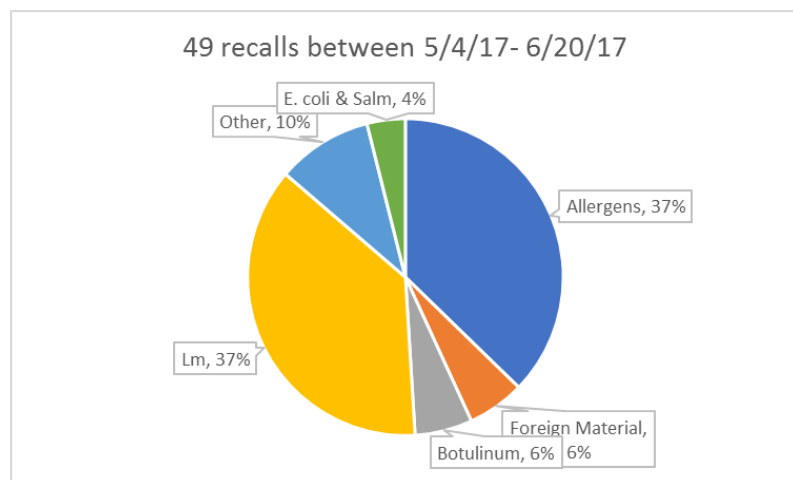
4. Research Needs (from Ferreira et al, 2014)

- Are certain Lm traits critical for or contribute to persistence?
- Are specific Lm subtypes that are specifically associated with food and nonfood micro- or macro-environments (e.g., a geographical region) or animal populations?
- What factors affect persistence of Lm food-associated environments and transfer of persistent strains to foods?
- Are quantitative approaches needed to define when re-isolation of a specific Lm subtype reflects true persistence or is it just a random re-isolation of a common subtype?

5. Hygienic Design of Equipment and Facilities

Like most food facilities, older produce operations (both fresh-cut and packinghouses) were not necessarily designed with food safety in mind. Increasingly this is changing, but the industry has only recently engaged with equipment manufacturers to begin conversations about re-designs that are more cleanable and less likely to harbor *Listeria*. Companies should seek to develop master sanitation schedules that thoroughly clean equipment at appropriate intervals (often involving full disassembly of equipment), and consider sanitary design principles when purchasing new equipment. Produce-specific checklists are available for reference (<http://www.commercialfoodsantiation.com/documents/>).

Produce Associated U.S. Lm Foodborne Illness Outbreaks and Recalls (Facts & Figures)



Zero Tolerance: FDA essentially has a “zero tolerance” for *L. monocytogenes* in ready to eat foods. The detection of the pathogen at any level in a RTE food, including one that doesn’t support growth, is cause for a recall. Recalls due to *L. monocytogenes* are on the rise, as shown in the table (for all FDA regulated food products).

2011: Cantaloupes from Colorado

- 146 persons in 28 states infected
- 5 Lm outbreak strains
- 33 deaths and one miscarriage
- Deadliest foodborne disease outbreak in the United States in nearly 90 years
- 1st Lm outbreak associated with fresh whole cantaloupe
- Lm previously considered a fresh-cut issue
- Potential Contributing Factors: Facility sanitary design, Equipment sanitary design, Postharvest practices
- Source: FDA Environmental Assessment: Factors Potentially Contributing to the Contamination of Fresh Whole Cantaloupe Implicated in a Multi-State Outbreak of Listeriosis (October 19, 2011)

<http://www.fda.gov/Food/FoodSafety/Foodbornellness/ucm276247.htm>

2014: Stone Fruit from a California Packinghouse

- First reported link between human listeriosis and stone fruit
 - *“Strong evidence linked one case in Massachusetts to recalled stone fruit, including food exposure interviews, receipt and shopper card data, and whole genome sequencing results showing very high genetic relatedness between the patient’s isolate and isolates from nectarines.”* CDC MMWR 3/15
- Australian fruit importer notified the firm it had detected Lm on its product
- Firm sampled and tested physical plant and products
- Firm issued a voluntary limited recall, in consultation with the U.S. FDA
- Canadian Food Inspection Agency issued a recall on the fruit packed by the firm
- Firms expanded its recall to all products packed by the company between June 1 and July 17, 2014
- Potential Contributing Factors: Unknown
- Public Health outcomes;
 - *“Although exposure to this recalled product was likely widespread, disease was very rare. Therefore, this recall and associated illness does not provide sufficient evidence*

- *to recommend that persons at higher risk for listeriosis (e.g., pregnant women, persons aged ≥65 years, and immunocompromised persons) avoid fresh stone fruits*
- *However, it does support the need to understand risks associated with contaminated, ready-to-eat fresh fruit so that prevention strategies can be strengthened.” CDC MMWR 3/15*

- Sources:

- Notes from the Field: Listeriosis Associated with Stone Fruit — United States, 2014 MMWR Weekly March 20, 2015 / 64(10);282-283
<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6410a6.htm>
- Wegmans and *Listeria*: Developing a Proactive Food Safety System for Produce – A Harvard Business School Case Study R. Goldberg and C. Snively, 2015.

2014: Apples from a California Packinghouse Consumed as Caramel Apples

- 32 persons in 11 states infected
- ? Lm outbreak strains
- 7 deaths and one miscarriage
- 89% of ill persons ate caramel apples
- 1st Lm outbreak associated with whole fresh apples
- Reported product and environmental sample positives
 - 6 zone I Lm+ PFGE match (polishing brushes, drying brushes, auto line singulator, pack line floor)
 - 1 zone III Lm+ PFGE match (wooden bin)
 - 5 subsample Lm+ PFGE match from Bidart whole fresh apples in commerce
- Potential Contributing Factors: Facility sanitary design, Equipment sanitary design, Postharvest practices, use as an ingredient in caramel apple
- Sources:
 - *FDA Investigated Listeria monocytogenes Illnesses Linked to Caramel Apples* (February 13, 2015)
<http://www.fda.gov/Food/RecallsOutbreaksEmergencies/Outbreaks/ucm427573.htm>
 - <http://bidartapplerecall.com/>

FDA Lm Policy

FDA & USDA FSIS Lm Risk Assessment

In 2003, the FDA Center for Food Safety and Applied Nutrition and the USDA Food Safety and Inspection Service published a “Quantitative Assessment of Relative Risk to Public Health from Foodborne *Listeria monocytogenes* Among Selected Categories of Ready-to-Eat Foods.” This risk assessment characterized fruits and vegetables as having a “low predicted relative risk of causing listeriosis on a per serving basis.” However, it was noted that while the contamination levels and growth rates on vegetables was anticipated to be low, the contamination rates for fruits was high, leading to a high level of uncertainty and need for more information about this food category. This risk assessment in its entirety can be found at:

www.fda.gov/downloads/Food/FoodScienceResearch/UCM197330.pdf

FDA Draft Lm Policy

In 2008, FDA issued “Guidance for Industry: Control of *Listeria monocytogenes* in Refrigerated or Frozen Ready-To-Eat Foods;” DRAFT Guidance which contained nonbinding recommendations and was distributed for comment purposes only. This document was never finalized, and instead, in January 2017, FDA released “Draft Guidance for Industry: Control of *Listeria monocytogenes* in Ready To Eat Foods”, which represents a dramatic shift in the Agency’s thinking.

<https://www.fda.gov/RegulatoryInformation/Guidances/ucm073110.htm>

Although the guidance is not final, and is not binding even once final, it does represent FDA’s current thinking. The draft guidance covers the following topics:

- Controls on personnel
- Design, construction and operation of your plant
- Design, construction and maintenance of equipment
- Sanitation
- Controls on raw materials and other ingredients
- Process control based on formulating... (not generally applicable to fresh produce)
- Listericidal process controls ... (not generally applicable to fresh produce)
- Storage practices and time/ temperature controls
- Transportation
- Environmental monitoring programs
- Sampling and testing of ready to eat foods
- Analysis of data for trends
- Training
- Procedures to collect, prepare and test samples
- Records

Comments are due July 27, 2017 and PMA and United Fresh will both submit comments. Of key interest is FDA’s recognition that the mere detection of *Listeria* spp. does not automatically mean that Lm is present. FDA encourages testing for *Listeria* spp as opposed to testing specifically for *monocytogenes* and provides industry the opportunity to address potential issues without regulatory penalty, or the need to report the finding to FDA. Table 6, pasted below, outlines FDA’s recommended corrective actions, which are based on whether or not the food supports the growth of *Listeria* or not.

Table 6.--Corrective Actions when *Listeria* species is found in an environmental sample

	Non-FCS Food supports growth	Non-FCS Food does not support growth	FCS Food supports growth	FCS Food does not support growth*
Routine sampling positive #1	<ul style="list-style-type: none"> • Clean and sanitize area of positive • Retest during next production cycle 	<ul style="list-style-type: none"> • Clean and sanitize area of positive • Retest during next production cycle 	<ul style="list-style-type: none"> • Clean and sanitize area of positive • Retest during next production cycle • Conduct comprehensive investigation 	<ul style="list-style-type: none"> • Clean and sanitize area of positive • Retest during next production cycle • Conduct comprehensive investigation
Follow up sampling positive #2	<ul style="list-style-type: none"> • Intensified cleaning and sanitizing (possibly including disassembly of equipment) • Intensified sampling and testing 	<ul style="list-style-type: none"> • Intensified cleaning and sanitizing • Intensified sampling and testing 	<ul style="list-style-type: none"> • Intensified cleaning and sanitizing (including disassembly of equipment) • Intensified sampling and testing • Hold and test product • Reprocess, divert or destroy product on hold if there is positive product • Comprehensive investigation 	<ul style="list-style-type: none"> • Intensified cleaning and sanitizing (including disassembly of equipment) • Intensified sampling and testing • Consider hold and test • Comprehensive investigation

Table 6, Continued.

	Non-FCS Food supports growth	Non-FCS Food does not support growth	FCS Food supports growth	FCS Food does not support growth*
Follow up sampling positive #3	Root cause analysis	Root cause analysis	<ul style="list-style-type: none"> • Stop production and consult experts for comprehensive investigation • Intensified cleaning and sanitizing (escalated, e.g., steam equipment) • Intensified sampling and testing • Resume production with product hold and test until 3 consecutive days of product and FCSs are negative 	<ul style="list-style-type: none"> • Intensified cleaning and sanitizing (including disassembly of equipment) • Intensified sampling and testing • Hold and test product • Expand comprehensive investigation • Hold and test product • Reprocess, divert or destroy positive product lots
Follow up sampling positive #4				Stop production and consult experts for comprehensive investigation

In the draft guidance, FDA recommends that facilities swab zone 1 product contact surfaces mid-production, and conduct occasional finished product testing as verification.

Critical to the produce industry is the **definition of a ready to eat food** (defined in the Preventive Controls rule). An RTE food is “any food that is normally eaten in its raw state or any other food, including a processed food, for which it is reasonably foreseeable that the food will be eaten without further processing that would significantly minimize biological hazards.”

p56147 <https://www.gpo.gov/fdsys/pkg/FR-2015-09-17/pdf/2015-21920.pdf>

FDA Lm Policy and Applicability to Fresh Produce

Fresh produce poses a unique challenge among FDA regulated foods in that *L. monocytogenes* is a microorganism that is routinely found in the outdoor environment, and its occasional transient detection on raw produce in low numbers does not necessarily indicate poor practices or that a contamination event has occurred, due to insanitary conditions, or that it presents an elevated public health risk. This means the occasional detection of transient *L. monocytogenes* in low numbers on fresh produce RACs and food contact surfaces, where fresh produce is handled, is to be expected and must be considered and addressed in the drafting of finished product and environmental monitoring procedures for fresh produce facilities.

Finished Product Testing: Many FDA regulated manufacturer/processors routinely conduct product testing; however, this is not the case for most fresh produce establishments that handle RACs. In the FDA Preventive Controls rule (response to comment 525) FDA states “We do not expect either product testing or environmental monitoring to be common in facilities that process, pack, or hold produce RACs. ... We expect that many facilities that process, pack, or hold produce RACs that are RTE foods may conclude, as a result of their hazard analysis, that neither product testing nor environmental monitoring is warranted. We also expect that many facilities that process, pack, or hold produce RACs that are RTE foods will conclude that the limitations of product testing when applied to produce reduce the value of product testing for their products and would direct their resources to food safety practices and verification measures other than product testing.” Due to the low prevalence, low numbers and random nature of Lm on RACs, finished product testing is not routinely used in the RAC produce industry as most produce establishments choose to not expend resources on product testing and instead focus on implementation and verification of preventive controls such as Good Agricultural Practices and Good Handling Practices.

Environmental Monitoring: The produce industry is acutely aware of the adverse public health consequences that can be associated with *L. monocytogenes* and largely embraces the strategy of seeking, destroying and preventing harborages of *L. monocytogenes* in produce facilities. However, FDA’s new draft Lm guidance seeks to promote the use of the “seek and destroy” environmental monitoring strategy. In the updated draft guidance, FDA has attempted to align their *Listeria* guidance with the USDA FSIS “Compliance Guidelines to control *Listeria monocytogenes* in post-lethality exposed ready-to-eat meat and poultry products.” These policies provide industry with regulatory flexibility that does not dis-incentivize use of the “seek and destroy” strategy when transient positive detections of *Listeria spp. or Listeria-like* organisms occur. An excellent review of the “seek and destroy” process can be found in Malley et al, 2015 (Journal of Food Protection 78(2) 436-445) and J. Butts Food Safety Magazine April/May 2003 www.foodsafetymagazine.com/

FSMA Preventive Controls for Human Foods

The FSMA preventive controls for human foods rule sets standards for firms which manufacture, process, pack or hold human food. This includes produce businesses throughout the produce supply chain such as packing house operations that are FDA registered facilities and fresh-cut processors. It proposes that firms covered by this rule would be required to have written plans that identify hazards, specify the steps that will be put in place to minimize or prevent those hazards, identify monitoring procedures and record monitoring results, and specify what actions will be taken to correct problems that arise. Importantly, the rule requires registered food facilities including packing house operations to assess the risk of environmental pathogens, and, if warranted, implement product testing (incoming raw materials, in-process and/or finished product), environmental monitoring and supplier controls.

Preventive Controls for Lm in or on Fresh Produce

Recent produce associated foodborne illness outbreaks and product recalls have made the produce industry acutely aware of the potential adverse public health consequences that can be associated with *Lm* and fresh produce. As a consequence, the produce industry reviewed procedures, policies and practices that may contribute to Lm contamination of produce and has developed a number of guidance documents. The United Fresh Produce Association “*Guidance on Environmental Monitoring and Control of Listeria for the Fresh Produce Industry*,” published in

2014, is currently the most comprehensive resource available to produce industry professionals. This exhaustive, fully referenced guidance document draws upon the lessons learned in other industry and the extensive scientific literature. It cites previous FDA guidance, and will therefore be updated in the near future based on our current understanding of Lm and current FDA rules and policies. Another important industry resource is the 2015 paper entitled “*Listeria* Guidance and Best Practices in Produce Facilities” from the Feb/Mar Issue of Food Safety Magazine (pp 58-63).

In 2013, the Center for Produce Safety Research Symposium included a workshop focused on *Listeria* biology and lessons learned on *L. monocytogenes* control from the meat and produce industries. The symposium drew upon lessons learned from the processed deli meat industry, whom faced similar issues with *L. monocytogenes* ten years ago and adopted a "seek and destroy" strategy.

In general, key elements of an Lm preventative program for fresh produce are:

- Comprehensive Good Agricultural Practices (GAP) program at the field level to keep the incidence of *Listeria* introduction into the packing or processing environment low,
- Work flow patterns within the facility that reduce the potential for cross-contamination,
- Equipment of sanitary design to reduce the potential for *Listeria* harborages,
- Thorough facility cleaning and sanitation
- a risk-based environmental testing program to verify the efficacy of cleaning and sanitation programs. Note: it is critical that root cause analyses follow any positive tests from environmental monitoring to better understand why the occurrence happened and to implement corrective actions to prevent a reoccurrence.

Resources:

- *Guidance on Environmental Monitoring and Control of Listeria for the Fresh Produce Industry*, 2014, United Fresh Produce Association. http://www2.unitedfresh.org/forms/store/ProductFormPublic/search?action=1&Product_productNumber=42425
- *Listeria Resources*, by PMA Science and Technology committee. <https://www.pma.com/content/articles/2016/05/listeria-resources>
- *Listeria Guidance and Best Practices in Produce Facilities*. 2015. Food Safety Magazine Feb/Mar Issue: pp 58-63. <http://www.foodsafetymagazine.com/magazine-archive1/februarymarch-2015/listeria-guidance-best-practices-in-produce-facilities/>
- Suslow, T. and L. Harris 2000. Guidelines for controlling *Listeria monocytogenes* in small- to medium scale packing and fresh-cut operations. <http://anrcatalog.ucdavis.edu/pdf/8015.pdf>
- Tomkin, R.B. 2002. Control of *Listeria monocytogenes* in the food processing environment J. Food Prot 65(4)709-725.
- Tomkin, R.B. et al. 1999. Guidelines to Prevent Post-Processing Contamination from *Listeria monocytogenes*. Dairy, Food & Environmental Sanitation August Issue pp: 551-562.

If you have further questions please do contact any of the members of the PMA or United Fresh Safety and Technology Team Produce Safety team

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