Leafy Greens-Related Incidents in California: 1996-2016

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Abstract

Introduction: An increase in the number of outbreaks associated with produce has been noticeable in the literature with leafy greens as the most likely produce category. As one of the largest leafy greens producers in the US, many related foodborne illness incidents were traced to California.

Purpose: Conduct a historical overview of leafy greens incidents linked to California through complaints, routine surveillance sampling, disease outbreaks, and investigations covering 1996–2016. Develop a risk assessment tool based on overview outcomes to modernize emergency response efforts to foodborne outbreaks related to leafy greens by the California Department of Public Health Food, and Drug Branch (CDPH-FDB).

Methods: A systematic review was performed of all California leafy greens-related incidents based on data available covering 1996-2016. A database including environmental, epidemiologic and laboratory information of each incident was developed, and descriptive analysis performed to identify trends.

Results: In the 21 year period analyzed, 134 incidents were identified, the majority were surveillance incidents. Approximately, 2240 US cases of illness were reported (~300 California cases entailing 50 hospitalizations). The most prevalent hazard type was microbiological, in particular bacterial, and more specifically, pathogenic *Escherichia coli* O157:H7 (followed by *Salmonella*, and *Listeria monocytogenes*). Of all implicated vehicles, romaine and iceberg lettuce were most frequently implicated.

Significance: In California, the overview provided CDPH-FDB with a platform to (1) enhance its Food Safety Program, Emergency Response Unit, and California Food Emergency Response Team; (2) assist in more efficient investigation, response, control, and ultimately prevention of California-linked foodborne illness incidents, and (3) identify knowledge gaps and develop effective definitions, procedures, training, guidelines and policies that will serve to prevent future outbreaks. Nationally, outcomes provide insight into the findings of one of the largest leafy greens-producing states. Results may be used to prioritize limited food safety resources and aid in future leafy greens-related foodborne incident investigations.

Background

CDPH Food and Drug Branch

The CDPH-FDB is engaged in the environmental investigation of foodborne incidents linked to California. FDB has initiated a number of activities to furnish overviews of data from these incidents, including leafy greens-related incidents, in order to enhance the Food Safety Program in California, in response efforts, and in preventing foodborne illnesses.

Incidents

- Outbreak: ≥2 epidemiologically-related illnesses. Confirmed if epidemiologic or laboratory evidence links two or more cases of illness
- Complaint: consumer or CDPH employee generated grievance. Confirmed with documented evidence
- Investigation: CDPH-FDB inspection or sampling project transpired. All confirmed because there was enough evidence to conduct an investigation
- Surveillance: positive result identified during routine sampling. Confirmed with positive laboratory evidence

Materials and Methods

Materials

California leafy greens-related incident data (microbiological, epidemiological, traceback, and laboratory information) contributed by:

- Environmental information from the FDB Emergency Response Unit
- Epidemiologic information from the Infectious Diseases Branch (IDB) Disease Investigations Section (DIS)
- Laboratory information from the Food and Drug Laboratory Branch (FDLB)
- U.S. Food and Drug Administration

Methods

- Systematic review of reports and supporting documentation (e.g. traceback diagrams, environmental assessments, environmental sampling, epidemiologic reports, and laboratory reports, etc.).
- Performed descriptive analyses to characterize historic trends in leafy greens-related incidents.
- Calculated cumulative incidence of leafy greens-related illnesses in California.

Results

- 134 leafy green incidents reviewed by CDPH-FDB from 1996–2016: 70 surveillance activities, 46 outbreaks, 13 investigations, five complaints
- 129 confirmed (96%): 68 surveillance activities, 46 outbreaks, 11 investigations, and four complaints (Figure 1)

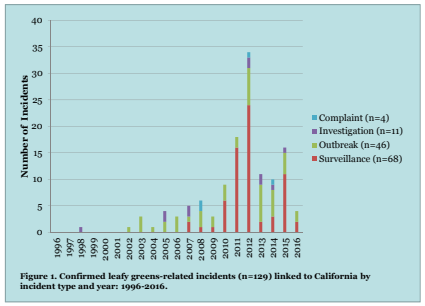

Figure 1. Confirmed leafy greens-related incidents (n=129) linked to California by incident type and year: 1996-2016.

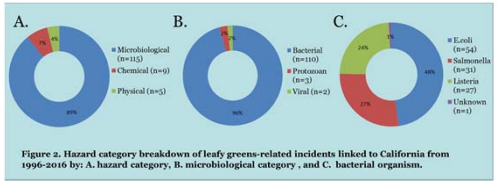

Figure 2. Hazard category breakdown of leafy greens-related incidents linked to California from 1996-2016 by: A. hazard category, B. microbiological category , and C. bacterial organism.

Results

- Figure 2 depicts a breakdown of identified hazard categories
- Nine chemical hazards: elevated cadmium levels
- Five physical hazards: two animal intrusions (cats and a flock of seagulls), and four foreign material contaminations (a dead mouse in a bagged salad, a live frog in a bagged salad, and two observed instances of fecal matter in a leafy green field during harvest). One incident had two physical hazards.
- 186 vehicles: 148 leafy green and 38 non-leafy green vehicles (ex. beef, carrots and sprouts)
- Lettuce and spinach were the most commonly cited vehicles, (39% and 26% of all implicated vehicles).

Lettuce Vehicle Type	Number	Percent of Total
Romaine Lettuce[1]	57	56.44
Iceberg Lettuce	22	21.78
Leaf Lettuce[2]	20	19.80
Lolla Rosa	1	0.99
Tango	1	0.99
Total	101	100

[1]Includes green, red, and unspecified romaine lettuce types
[2]Includes green, red, butter, green/red oak leaf lettuce types

- 2,429 reported illnesses (of which 2,239 occurred in the US) from 46 outbreaks and two surveillance incidents
- 291 California illnesses (25 incidents, 50 hospitalizations , and two deaths)
- Figure 3 illustrates an increase in all incident types in the fall transition period from the Central Coast to the Desert Southwest growing region.

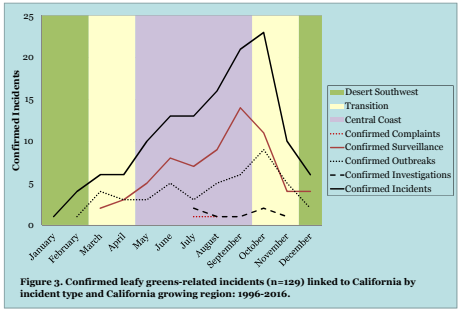

Figure 3. Confirmed leafy greens-related incidents (n=129) linked to California by incident type and California growing region: 1996-2016.

Results

3,850 samples collected (3,469 environmental, 312 product, and 69 control)

- 49% (n=1,894) collected in response to outbreaks, 27% (n=1,042) investigations, and 24% (n=914) surveillance
- 159 samples tested positive (4%; 229 isolates; 141 environmental and 18 product samples); 136 samples with unavailable results
  - Positive environmental samples: feces (n=53), soil (n=30), water (n=23), environmental swab (n=13), sediment (n=12), and leafy greens (n=10)
  - Positive product samples: baby spinach (n=5), iceberg lettuce (n=1), bagged romaine lettuce (n=2), unspecified spinach type (n=6), and spring mix (n=4)

Discussion

- The Salinas Valley in California and Desert Southwest (including Yuma, AZ, Northern Mexico, California's Imperial Valley) produce the overwhelming majority of lettuce for the US market. An increase in incidents in the fall transition period (Figure 3) could indicate an issue in the transition process leading to leafy green incidents.
- California dealt with at least one outbreak per year since 2002, the majority of which (48%) were caused by pathogenic *E. coli*.
- Lettuce and spinach were the top implicated leafy green vehicles out of all confirmed vehicles (39% and 26%, respectively), which could be a reflection of consumer demand and/or availability increase.
- Details pertaining to processing type (i.e. chopped, frozen, etc.) and growing operation (organic vs. conventional) need to be documented, as these processes increase post-harvest contamination possibilities.
- Expansion of this historical overview database to include other food commodities and up-to-date incidents will provide more efficient access to all pertinent information and ability to analyze and compare situations to identify patterns in leafy green incidents and to highlight potential sources of contamination along the food production chain. This will ultimately aid CDPH Emergency Response Unit in response efforts and preventing foodborne illnesses.

Future Work

- Complete Whole Genome Sequencing on all positive isolates and perform relatedness analysis.
- Perform similar projects and analyses for other commodities associated with foodborne incidents linked to California.

Acknowledgements

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- Infectious Diseases Branch
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