

***Listeria monocytogenes* in Fresh Fruits and Vegetables**

Master's degree in Agriculture and Life Science

By

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Introduction

Approximately 1600 illnesses and 260 deaths in the United States are caused by food contaminated with *Listeria monocytogenes* (CDC, 2014; Scallan, et al, 2011). *Listeria monocytogenes* is a Gram-positive bacterium (Vaquez-Boland, Kuhn et al, 2011) that causes the infection listeriosis within the body. *L. monocytogenes* can be found in ready to eat (RTE) foods. Unlike other foodborne pathogens, one of the organisms unique characteristics is that it is a psychrotroph, meaning it can grow in refrigeration temperatures; therefore, refrigeration is not the most effective way to control the pathogens growth (figure 1) (Frazer, 1998), even when temperatures almost reach freezing.

Figure 1. Temperature growth ranges for select foodborne pathogens

Microorganism	Growth Range (°F)
<i>Salmonella</i> sp	41.4°F – 115.2°F
<i>Clostridium botulinum</i> A&B	50.0°F – 118.4°F
<i>Clostridium botulinum</i> Non-proteolytic B	37.9°F – 113.0°F
<i>Clostridium botulinum</i> E	37.9°F – 113.0°F
<i>Clostridium botulinum</i> F	37.9°F – 113.0°F
<i>Staphylococcus aureus</i>	44.6°F – 122.0°F
<i>Yersinia enterocolytica</i>	29.7°F – 107.6°F
<i>Listeria monocytogenes</i>	31.3°F – 113.0°F
<i>Vibrio cholerae</i> 01	50.0°F – 109.4°F
<i>Vibrio parahaemolyticus</i>	41.0°F – 111.0°F
<i>Clostridium perfringens</i>	50.0°F – 125.6°F
<i>Bacillus cereus</i>	39.2°F – 131.0°F
<i>Escherichia coli</i> (pathogenic types)	44.6°F – 120.9°F
<i>Shigella</i> spp.	43.0°F – 116.8°F

Frazer, A. M., 1998: Control by Refrigeration and Freezing

The infection listeriosis, can affect people of all ages, but predominantly present in those with weakened immune systems such as pregnant women, newborns and those who are elderly (CDC, 2014). Foods such as soft cheeses, spreads, smoked and raw seafood, sprouts, fruits, vegetables, poultry, soil, water, sheep, cattle, processed foods; dairy foods have all been linked to listeriosis cases (CDC, 2014). According to the CDC, (2014), symptoms of

listeriosis are very similar to symptoms such as the flu. These symptoms can be described as fever, nausea, diarrhea, aches, and can even affect the nervous system causing one to be unbalanced. With out the proper care of one's body once noticing symptoms related to listeriosis or any other sickness related to a foodborne pathogen, without treatment, it could lead to death of those with weak immune systems and even stillbirth of an unborn child.

Contamination of Foods by *L. monocytogenes*

Contamination of foods by *L. monocytogenes* can occur in homes, restaurants, transportation of food or right on a farm. This could all take place through the mishandling of foods and the lack of good hygiene when touching foods. Contamination can also take place within food processing facilities and farms where equipment and bare hands are used to harvest, move, and transport food, and even restaurant practices result in contamination and/ or spread of *L. monocytogenes*. Contamination is especially possible when there is a lack of proper cleanliness of equipment within food processing facilities. This could be due to the eagerness by producers and sellers to release foods into the market. Improper cleaning of food processing equipment can lead to cross contamination of foods during processing. There are even issues when restaurants fail to properly clean their counter tops using proper cleaning solutions, properly storing of RTE foods, and workers washing their hands.

RTE foods have been linked to a number of cases of listeriosis. RTE foods are convenience foods that have been processed such that they are ready

for the consumer to eat without any additional cooking steps. According to Brazos County Health department of Texas (2013), produce such as leafy greens (endive, lettuce), cooked hamburgers, and cheeses just to name a few are described as ready to eat foods and can be carriers of listeriosis. They can be served as plated foods eaten everyday in homes, restaurants, and being sold in grocery stores from farm to fork. Attention when dealing with RTE foods should come with proper handling and transportation of these foods through monitoring, testing, and use of proper hygiene.

How *L. monocytogenes* causes illness

L. monocytogenes is a pathogen that can be carried by soil and water as well as by contaminated tables, food utensils, and tabletops. Once the contaminated food products are ingested, the bacterium can multiply becoming acute or chronic in the gastrointestinal tract. Symptoms of the illness do not always present right away. There can be a long period of time between ingestion and onset of illness. *L. monocytogenes* can survive within the body, moving between cells (human phagocytes) without noticeable symptoms. *L. monocytogenes* begins to kill and/ or damage the cells of the body, which keeps it functioning. Symptoms of illness can be presented quickly (acute) or maybe take weeks to identify (chronic), depending on the virulence of the particular strain of *L. monocytogenes* and how weak ones immune system is during time of infection.

Symptoms of listeriosis, which is the infection of listeria are similar those of the flu virus. Not all symptoms are the same, but pose similarities in sickness to the body. If infected, one can consist of sweating, vomiting, dizziness, fevers, chills, nausea and/ or diarrhea which are symptoms identifying infection within the gastrointestinal (CDC, 2014; Marler Clark, 2016).

Once effectively diagnosed, listeriosis can be treated using immediate IV antibiotic treatment to prevent, halt, or slow the development of the bacteria within the body (Medicine.net, 2015). Without immediate treatment, ones sickness can become to worsen, even leading to death.

Contamination of produce by *L. monocytogenes*

A food product can become contaminated with a foodborne pathogen such as *L. monocytogenes* anywhere along the pathway of food production (planting, harvesting, packing, distribution, serving, etc...). Sources of contamination by *L. monocytogenes* can be anywhere in the environment, for example: irrigated waters, wash waters, and soil. For example, heavy rains on a crop (especially a crop that grows low to the ground such as cantaloupes) where there is contamination of soil, the splash of rain could splash bacterium onto the edible surface, thus, contaminating the product. According to Locarelli, A. et al, 2013 a bacterium such as *L. monocytogenes is edaphic*, lasting up to 84 days in some soils giving the possibilities of contamination in low growing produce higher if present in the soil.

Not all soils and waters is contaminated with *L. monocytogenes*, in fact, most is not contaminated. However, in farm areas, the soils and waters can become contaminated by the use of raw or improperly composted manure. Improperly composted manure can become a food safety issue because manure can contain foodborne pathogens. The composting process will kill off pathogens, but if it is done incorrectly, the pathogens can survive. Major products used as composted manure for crop consist of chicken and cattle feces and animal carcasses, which can contain foodborne pathogens and ultimately contaminate crops, and water sources that they come in contact with (Nightingale, Fortes, Ho, Her, Wiedmann, 2004). If raw manure is applied to crops, it can contaminate water table through leaching, runoff, and by irrigation waters which increases in the risk of soil and vegetables then becoming contaminated (Locatelli et al.2013) by *L. monocytogenes*. *L. monocytogenes* can survive in soil for up to 84 days Locatelli et al. (2013) during which time the food products could become contaminated. If produce becomes contaminated during the growing period, harvesting the produce can result in the cross contamination, or even increased growth of the organism. Those working in the packinghouses, pooled water on floors being splashed, touched by equipment, can spread contamination. Once contaminated products are moved from the field to other locations, spreading among other produce and equipment of *L. monocytogenes* begins.

Contamination of *L. monocytogenes* in the post-harvest environment

According to Vorst, Todd, Ryer, (2006), *L. monocytogenes* can survive well in food processing plants, as well as on your kitchen counter top, and can transfer from one food item to the next, just by touching an area that is contaminated. Produce items such as sprouts, lettuce, other leafy greens, broccoli, cantaloupes, mangos, strawberries (Beecher, C. 2013) can become contaminated when irrigated with wash waters contaminated with *L. monocytogenes*, or from soil contacting the produce that contains *L. monocytogenes*. In a packinghouse, if a produce item is contaminated and placing in to wash water, or a dump tank with other items, the other items can become cross contaminated. Other ways that cross contamination can occur is during mixing with other products or contacting contaminated surfaces during shipping, storage and at retail.

One example of how cross contamination played a key role in outbreaks is with the Jensen farms *L. monocytogenes* outbreak. In 2011, *L. monocytogenes* was found on conveyer belts, including packing and shipping equipment on Jensen Brother farm in Colorado. Contamination of *L. monocytogenes* from these locations led to cross contamination of cantaloupes on the farm. These cantaloupes were distributed to a number of states and resulted in listeriosis identified in 28 states (Rothschild, M. 2011) to affect 146 people, and claiming the lives of more than 33 people (Bill Marler, 2014). Prior to the investigation, which identified the Jensen Brothers Farm as the culprit of the contamination of *L. monocytogenes* in cantaloupes, a third party audit company 'Primus' had completed what was considered a thorough inspection of the equipment and

facilities use to store, pack and transport the cantaloupes after harvest. The auditor graded Jensen Farming facility with a superior rating of 96%, but also indicated there was no “antimicrobial wash” (Bronstein and Griffin, 2012) on the cover of the inspection form.

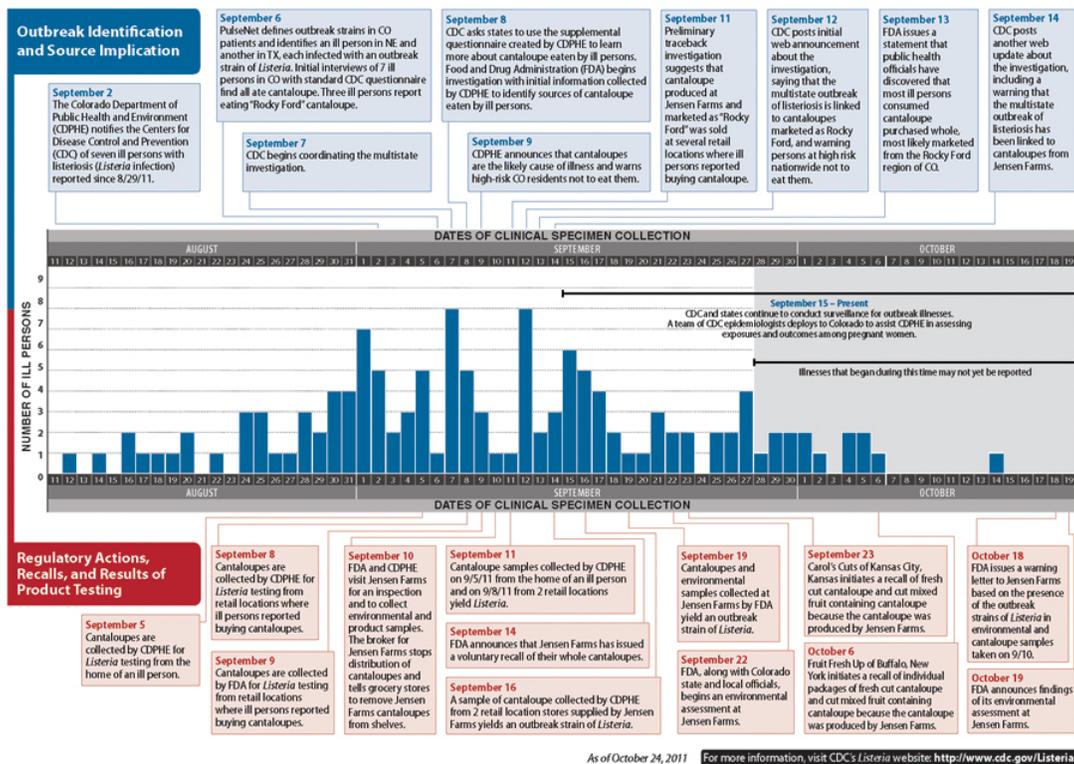
According to EcoLab (2015) antimicrobial wash reduces 99.9% of pathogens such as *Listeria*. Within the records, Jensen Farm used regular wash water instead of antimicrobial wash water. There was water that pooled on the floors in the packing facility near conveyer belts equipment and areas where sitting and movement of cantaloupes were located. Equipment that was used in the facility was considered hard to wash as well as used equipment that had once been used to move potatoes, which are tuber plants, which sit in the soil. Soil can become contaminated with *L. monocytogenes*, and pose as moving mechanism for the possible transport, infecting equipment and other surrounding food products.

According to Bronstein and Griffin (2012) the entire operation could have stopped before the first person had become sick and before anyone had died, if more attention was paid to the proper protocol by the auditor for Primus. This proper protocol would have been for the Jensen Farm to automatically be shut down due to not using the proper sanitizing solution within the wash water during movement upon the conveyer belts to be dried and packed.

Figure 2. Timeline of Events: Multistate outbreak of listeriosis linked to whole cantaloupes from Jensen Farms in Colorado – United States, 2011

Timeline of Events: Multistate Outbreak of Listeriosis Linked to Whole Cantaloupes from Jensen Farms in Colorado—United States, 2011

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Contamination during produce distribution:

When produce have been distributed to become a part of meals as sources of nutrition in homes, the possibility of consumers being affected is highly likely. During the process of farm to fork with produce such as cantaloupes, *L. monocytogenes* can enter the fruit through the rough coded rinds, puncture wounds on the fruit which can be caused by mishandling during movement within the factory, transport, or within supermarkets after being in contact with other fruits or unsanitary location that are contaminated.

Contamination in the retail environment:

Within a restaurant, to avoid the spread of foodborne pathogens such as *L. monocytogenes* hygiene should be put first as a priority. According to the CDC, hand washing should take place before and after handling foods. Anytime there is a change in food uses, such as going from potatoes to cantaloupes, hand washing and cleaning of equipment should take place after using the restroom, sneezing and coughing in ones hands, touching ones hair, handling money, or handling animals. If a food worker is sick or have been around sick people, sneezing and coughing, had massive diarrhea, one should stay at home and seek medical treatment help as soon as possible due to the possibilities of being contaminated with a foodborne illness. When hand washing, it should take approximately 20 seconds using the recommended 5 step process provided by the CDC (2013):

- 1) Wet your hands with clean, running water warm water, apply soap.
- 2) Lather your hands by rubbing them together with soap. Be sure to lather the backs of your hands, between your fingers, and under your nails.
- 3) Scrub your hands for at least 20 seconds. Need a timer? Hum the Happy birthday song from beginning to end twice.
- 4) Rinse your hands well under clean running water.
- 5) Dry hands using a clean towel.

Within a home, *L. monocytogenes* can grow in the refrigerator at temperatures as low as 40 degrees Fahrenheit (4 degrees Celsius) (FDA, 2015).

The organism can be introduced through food that has been contaminated and added to an area with other produce. Contamination can occur from counter tops that have been improperly cleaned.

Though it has been said cooking can easily destroy that *L. monocytogenes*, but if not cook at temperatures of 170 degrees (FDA, 2015) or greater, possibilities of completely destroying the bacterium is low.

Major Recalls produce recalls due to *L. monocytogenes* contamination:

Besides the 2011 contamination of cantaloupes by the Jensen Brothers in Colorado, there was also the 2016 contamination of *L. monocytogenes* in frozen vegetable blends due possible contaminated onions. The two frozen steam vegetable blend products:

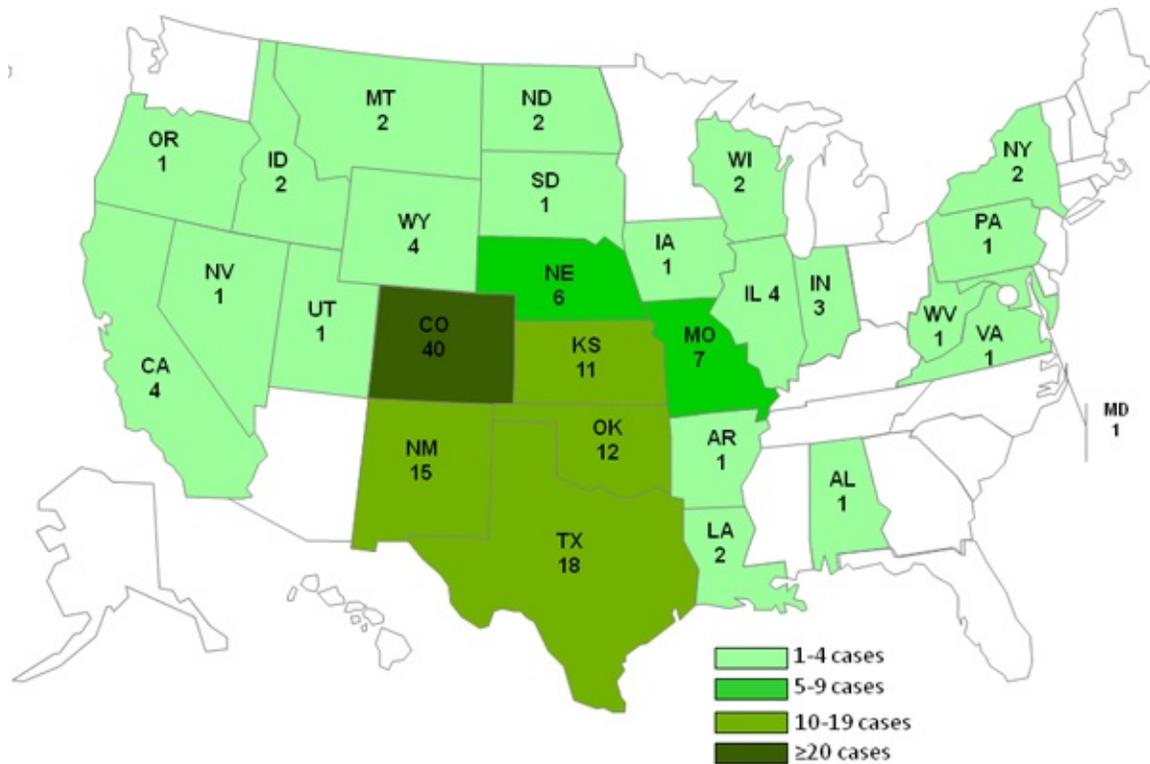
- Pictsweet Seasoning Blend, 12-ounce, UPC: 7056096902, Best by date: 4/2/2018; and
- Pictsweet Steamable Spring Vegetables, 10-ounce, UPC: 7056097826

Best by date: 3/19/2018.

(Beach, 2006, Food Safety News) were produced by the Pictsweet Co., where the onions were from Oregon Potato Co. (Beach, 2006, Food Safety News).

In 2015, Granny Smith and Gala Apples were recalled from Bidart Brothers of Bakersfield, Ca (CDC, 2015) due to test, which came back positive for *Listeria* in the packing plant. There were a total of 35 cases, 7 death, and 34 hospitalizations from 12 different states, and one in Canada, according to the CDC February 2015 *Listeria* outbreak report.

Figure 3. Map of cases of listeriosis from the Jensen Farms outbreak (CDC, 2012).



In both cases of the Jensen brothers' farm and the Bidart brothers operation, they both consist of contaminated equipment within the packing house, which tested positive for *L. monocytogenes*.

GMPs, SOPs and GAPs

In order to reduce microorganisms such as *L. monocytogenes* in RTE foods (perishable refrigerated, frozen foods, foods that do not need heating), Good Manufacturing Practices and Standard Operating Practices are developed

in order to have a successful Hazard Analysis Critical Control Point (HACCP). GMPs are practices used as a guidance to help minimize risk associated with foodborne illnesses within buildings where food is processed, and the equipment inside. SOPs are established as a form of training procedures for employees and consistent methods to be used to conduct daily operations

Bacteria like *Listeria* can be found almost anywhere (Suslow and Harris, 2000) and can contaminate anything. When wash water and condensation sit on floors close to food handling machinery, or when workers enter the building without properly decontaminating their shoes, moving all possibilities of contamination, a packinghouse can become contaminated. These are reasons why GMPs should be in practice and each packinghouse should have SOPs on hand at all times, as well as the SOPs provided to each employee.

According to Suslow and Harris, (2000), areas where listeria can become a potential threat in a packinghouse consist of the entire packing facility, from farm to fork such as

- Slicers, dicers
- Conveyers belts
- Holding bins, baskets, containers
- Packaging equipment for distribution
- Hand tools such as gloves aprons, knives
- Bottoms of workers shoes and hands

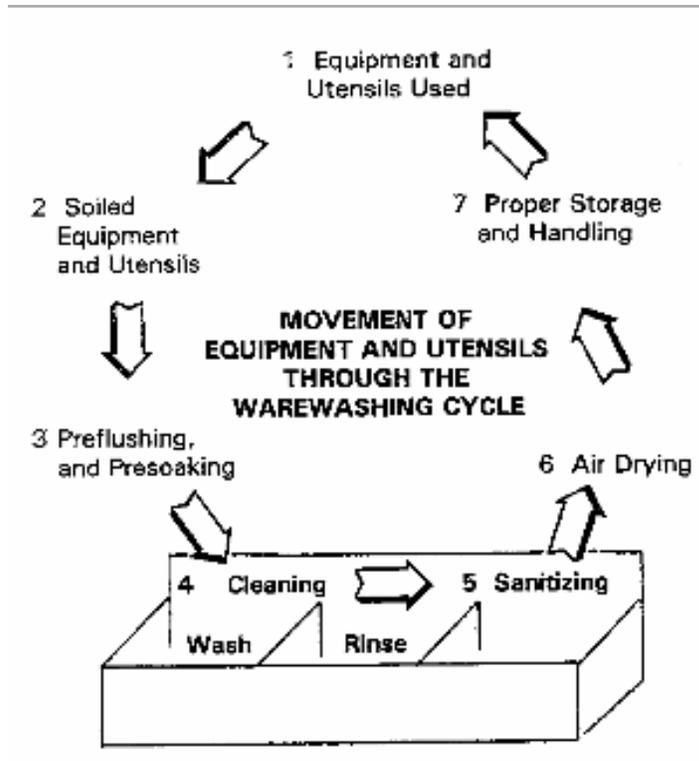
According to the Idaho Department of Health and Welfare, the purpose of cleaning and sanitizing food equipment serves two primary purposes:

- 1) Reduces chances for contaminating safe food during processing, preparation, storage and service by physically removing soil, bacteria and other microorganisms; and
- 2) Minimizes the chances of transmitting disease organisms to the consumer by achieving bacteriologically safe eating utensils.

Proper cleaning should take place in each facility after each use of a different food item in each facility. Also, there should be provided, to each employee, a step-by-step manual known as an *Operation Manual*, used so that each employee who handles food, is aware of and follow proper procedures. Each manual is used to show and provide direction on how to operate the cleaning and sanitizing of equipment, as well as how much and which chemicals should be used for proper cleaning. This will help to prevent foodborne illnesses such as *L. monocytogenes* in fresh fruit, vegetables and other RTE foods. These procedures should be located in every work site SOP.

Figure 4 (shown below, Idaho Department of Health and Welfare 2006) shows the wash cycle, which should be maintained and followed with equipment and utensils used to handle food products.

Figure 4. Visual guidance on how the movement of Equipment and Utensils through the ware washing cycle should be done.



GAPs (Good Agricultural Practices) while harvesting and preparing RTE (Ready to Eat) Foods identified in section 21 of the Code of Federal Regulations, part 110 (21 CFR part 110) focuses on preventing at all measure foodborne bacteria's such as *L. monocytogenes* from spreading due to hygiene. According to the 21 CFR part 110, every workplace handling foods should be able to have documentation on the training of all employees, providing directions on proper cleaning, washing and proper food handing. Before harvesting one should begin with the appropriate protection and monitoring of the surrounding are area in which the produce is to be harvest, touched and packed. Monitoring of areas to be harvest can consist of use of fencing to fence off wildlife animals from to control desiccation. Making sure all who work in the fields are not sick, monitoring coughing, sneezing, fevers, and other signs of body distress.

Monitoring all employees before, during and after working hours. This form of monitoring can take place through survey/ questionnaires to help determine the health and wellness of all employees. When it comes to good hygiene in the work place, according to the CDC, hand washing is an important factor in reducing the contamination of *L. monocytogenes* from farm to fork.

Conclusion

L. monocytogenes is a foodborne pathogen that can have serious consequences in RTE foods (like produce). By practicing proper hygiene and following local, state and governmental regulation, proper handling, storing and shipping can take place without the possibilities of contamination of *L. monocytogenes*. Contamination of produce with *L. monocytogenes* does not just occur in packing houses or fields. Contamination can also occur in restaurants and consumer kitchens, where the pathogen can grow in areas where foods are being handled and cooked, refrigerated and placed on un-cleaned countertops. *L. monocytogenes* is a real foodborne pathogen that spreads, and can be found all over the world, sickening all whom come in contact with it, even causing death. From farm to fork is important and affects us all. It chooses everyone and leaves no one out. We are all means of possible transmitters of this infectious disease. If you're sick, stay home and away from buffets or handling other peoples' foods. Seek medical attention and rest. We all have a job to do when it comes to insuring food safety and the safety of others.

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