

# A Simulation Study to Evaluate the Microbiological Safety of School Lunches Stored in Insulated Coolers During Field Trips



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## Introduction

- Field trips, often during warm weather seasons, present a food safety challenge for school nutrition programs, as providing a nutritious meal that has been stored and handled properly until serving may be difficult.
- “Sack lunch” meals are often stored in insulated coolers that accompany students on the field trip.
- Coolers are commonly stored on school buses, which are not temperature regulated, and may pose a risk to food safety.
- Understanding foodborne pathogen growth potential in school lunch meals packed into insulated coolers, transported on field trips, and exposed to elevated environmental temperatures prior to serving was the purpose of this research.

## Methods

- Temperature conditions for insulated cooler storage to be used in the simulation study were determined by monitoring school bus ambient temperature profiles using data loggers during May-June 2015 in North Carolina and Arkansas.
- Preliminary studies showed that two cooler packing strategies posed the most risk in terms of product temperature increases during simulation:
  - cooler packed with one layer of ice packs on the bottom
  - cooler packed using no ice (i.e., relying on temperature of chilled pre-prepared food items only)
- Lunches met U.S. National School Lunch Program standards, and included a turkey sandwich, sliced apples, and baby carrots.
- Lunch items were separately inoculated with *L. monocytogenes* or *Salmonella* spp. (~4 log CFU/g).
- Inoculated sack lunches were randomly placed in the top, middle, and bottom layers of each cooler packing scenario (Figure 1)
  - Each cooler contained 30 lunches (10 lunches per layer; one lunch inoculated with *L. monocytogenes* and one with *Salmonella* spp. within each layer)
- Coolers were placed within an electronically controlled thermal processing unit (smokehouse) and subjected to increasing temperatures (75-150°F; 24-66°C) over a 5-hour storage period (Table 1).
- Product temperatures were monitored continuously during simulation in lunches in the top and bottom layer of each cooler scenario by datalogger.
- Following the 5-hour simulation, serial dilutions of sandwich, sliced apple, and baby carrot samples were plated on selective media to enumerate changes in pathogen populations (control samples enumerated at time of placement into thermal processing unit).
- Data were analyzed using SAS MIXED; 3 replications were conducted.

Table 1. Thermal Processing Unit Simulation				
Step	Program	Relative Humidity (%)	Ambient Temp. (°F/°C)	Time (min)
1	Start			1
2	Drying	80	75/23.9	33
3	Drying	80	85/29.4	33
4	Drying	80	95/35	33
5	Drying	80	105/40.6	33
6	Drying	80	115/46.1	33
7	Drying	80	125/51.7	33
8	Drying	80	135/57.2	33
9	Drying	80	145/62.8	33
10	Drying	80	150/65.6	33
11	Stop			1

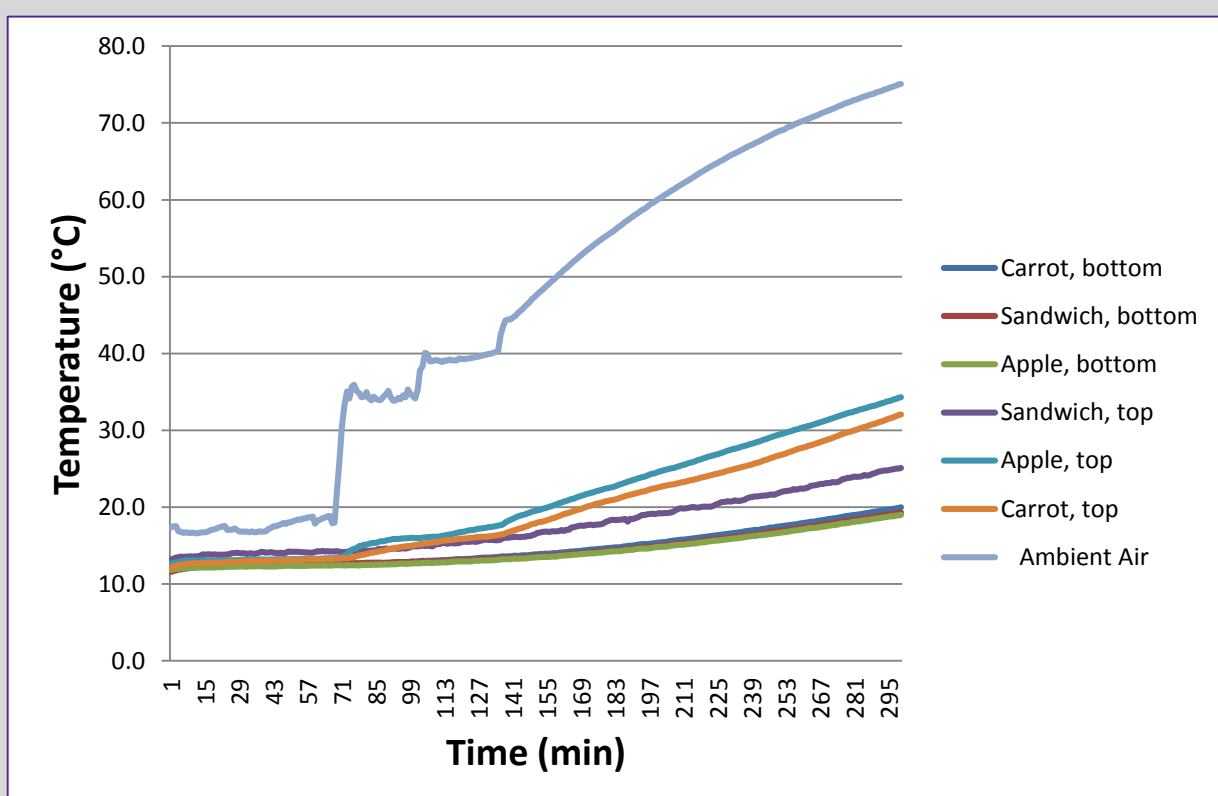
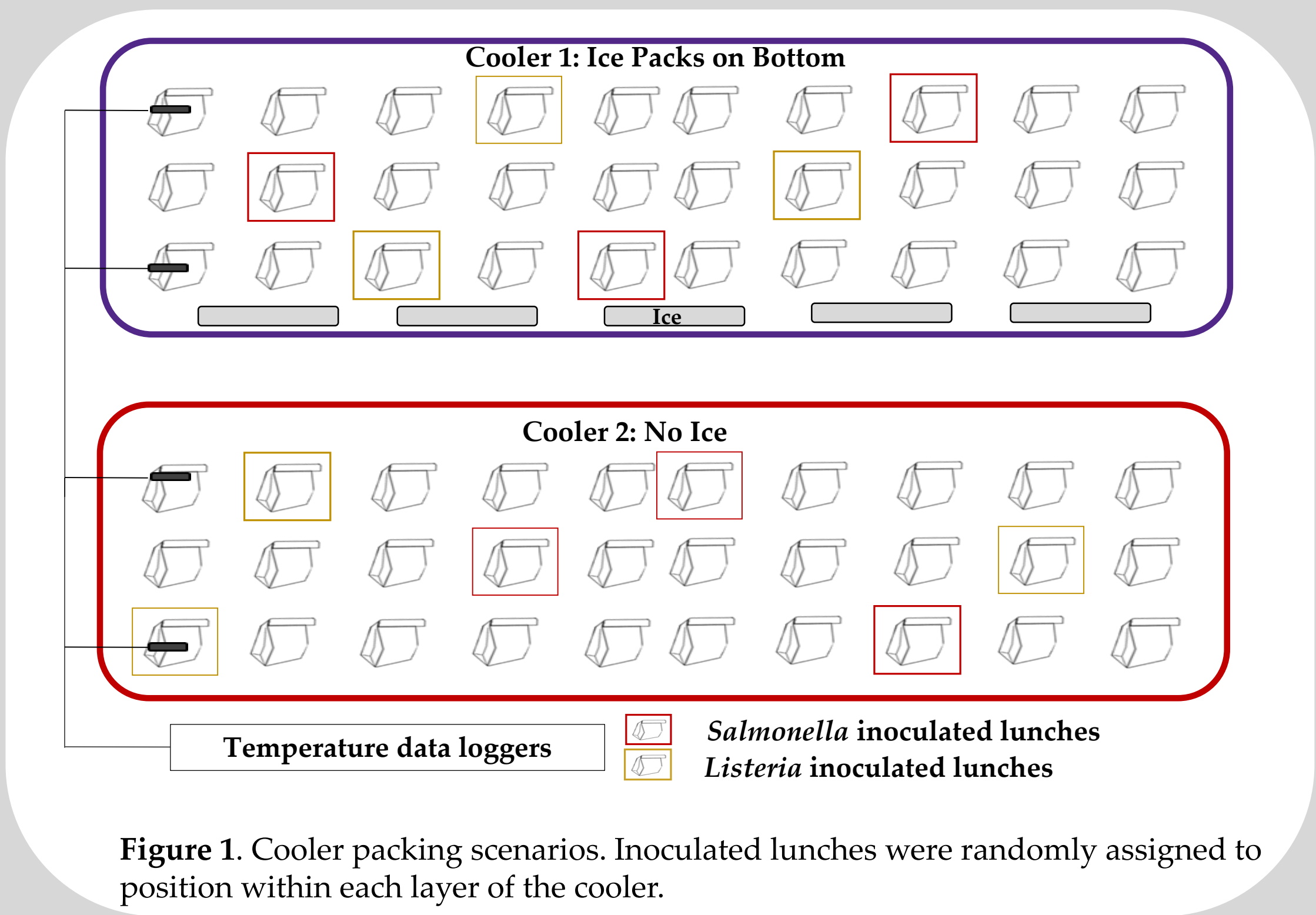


Figure 2. Product and ambient air temperature profiles for lunches packed in a cooler with no ice packs.

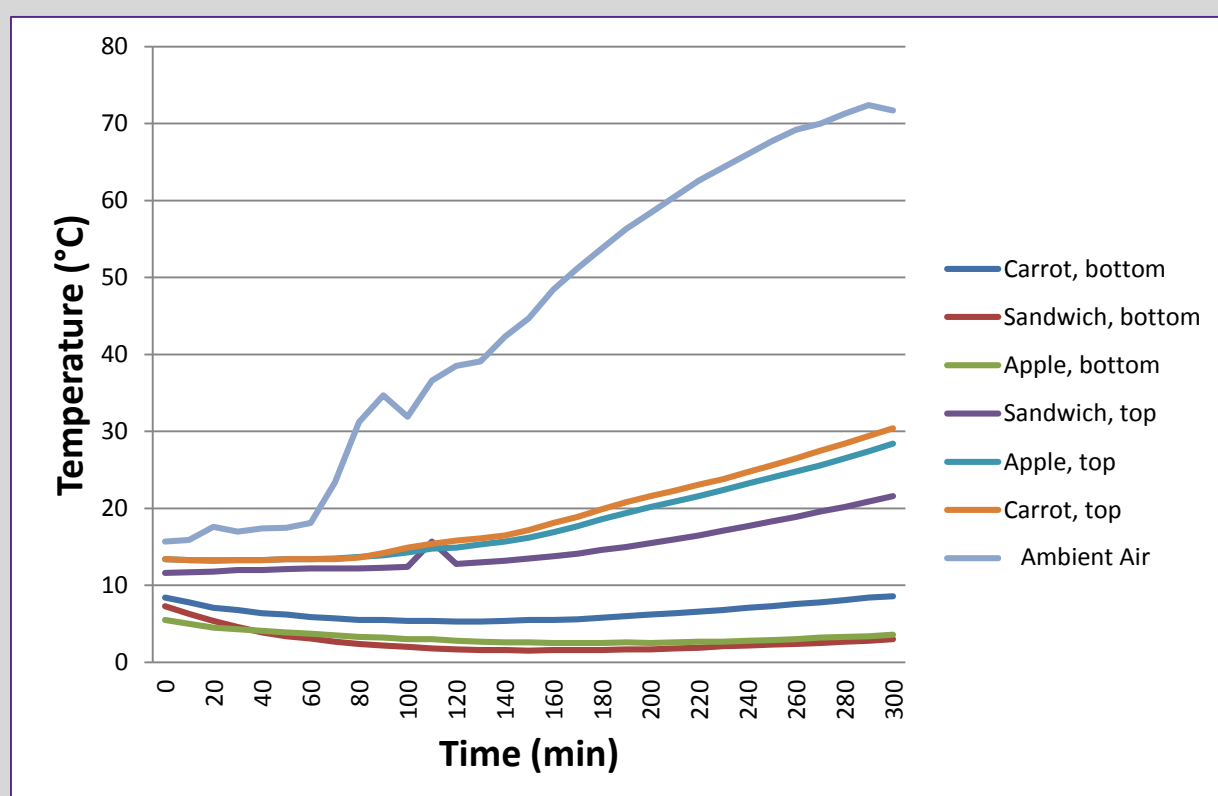


Figure 3. Product and ambient air temperature profiles for lunches packed in a cooler with a layer of ice packs on the bottom.

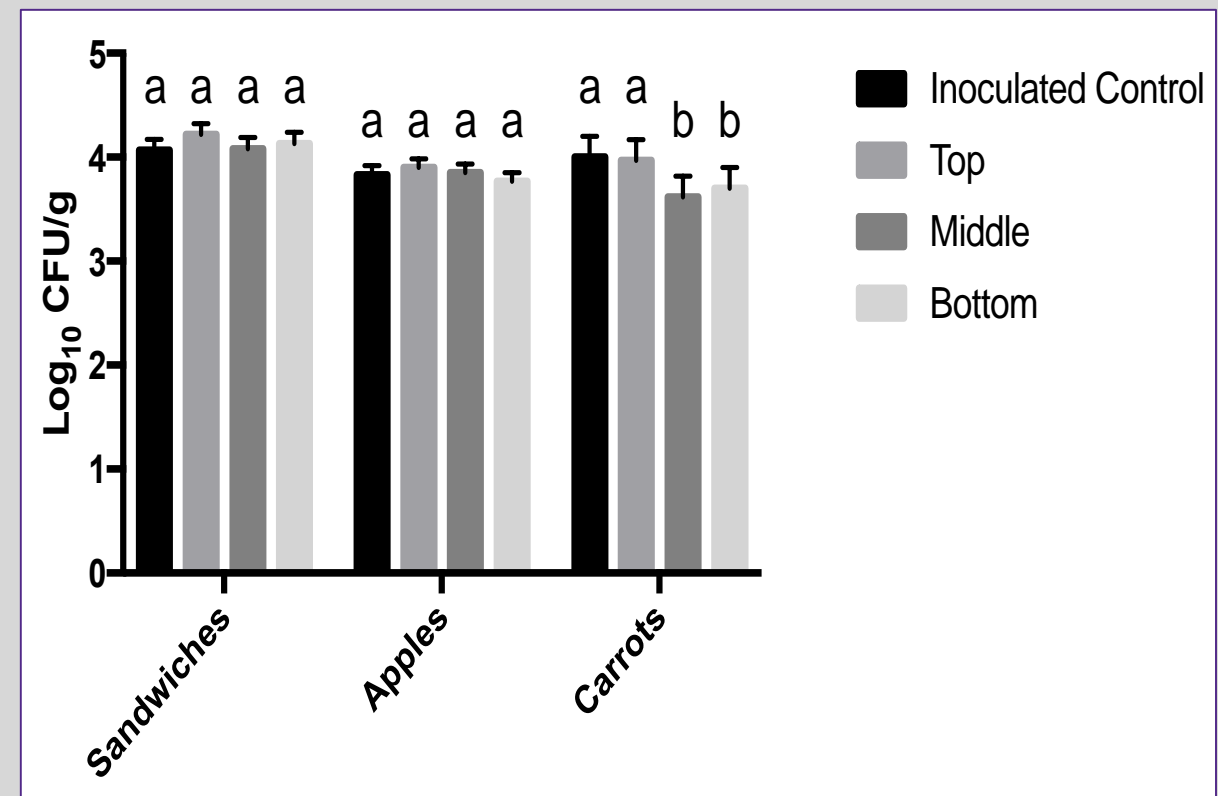


Figure 4. *Salmonella* populations on lunch items according to their location within the cooler. <sup>a,b</sup> Populations with different superscripts within each product are statistically different ( $P \leq 0.05$ ).

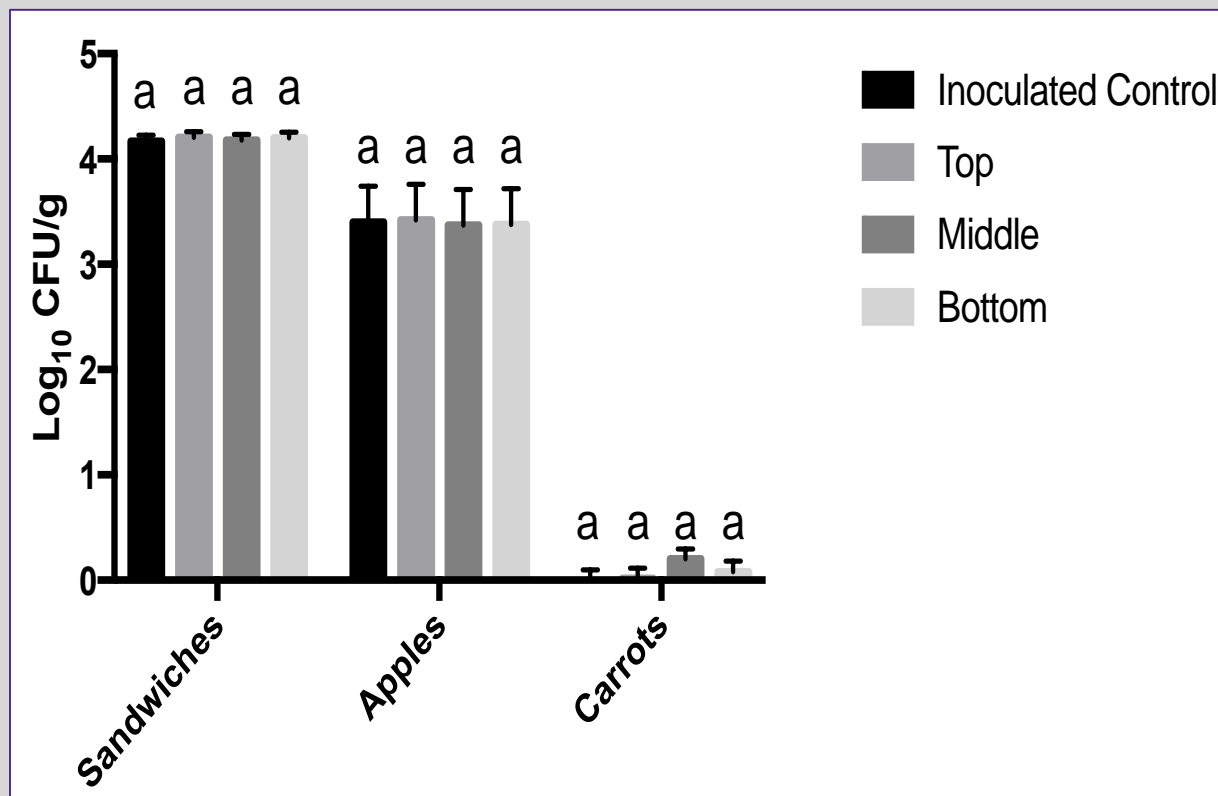


Figure 5. *Listeria monocytogenes* populations on lunch items according to their location within the cooler. <sup>a,b</sup> Populations with different superscripts within each product are statistically different ( $P \leq 0.05$ ).

## Results

- In coolers packed without ice, all foods were in the temperature danger zone (40-140°F; 4-60°C) for five hours (Figure 2).
- In coolers with ice packs on the bottom, foods in the top layer (and likely the middle layer where temperature was not monitored) were in the temperature danger zone for five hours (Figure 3).
- No differences ( $P > 0.05$ ) were observed in *L. monocytogenes* or *Salmonella* populations comparing time 0 controls and 5-hour populations between cooler packing scenarios (ice or no ice). Therefore, pathogen recovery graphs were averaged across packing scenarios (Figure 4 and 5).
- Product placement within cooler did not result in *L. monocytogenes* population changes (compared to controls) on sandwiches, sliced apples, or baby carrots.
- L. monocytogenes* populations after inoculation and 30 min of attachment were virtually non-recoverable on baby carrots.
- Product placement in coolers did not result in *Salmonella* population changes for sandwiches and sliced apples, but a slight population decline was observed on baby carrots placed in the middle and bottom layers of both cooler packing scenarios ( $P \leq 0.05$ ).
- This study suggests that time  $\leq 5$  hours is an adequate safety control for *Salmonella* and *L. monocytogenes* in the specific foods studied. This may not be the case for other pathogens or food types.

## Significance

- Although sandwiches, carrots, and apple slices were subjected to temperature abuse in both cooler packing scenarios, pathogen populations did not increase during the 5-h simulation.
- Therefore, storage time ( $\leq 5$  hr) as a public health control is effective for preventing foodborne pathogen growth on these specific food products.



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