A Simulation Study to Evaluate the Safety of Lunches Stored in Coolers in Extreme School Bus Temperatures

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**Introduction**

- Off-site field trips increase food safety risks due to elevated ambient temperatures and variable holding and service conditions.
- Meals are often prepared as sack lunches, stored in insulated coolers, and taken with teachers and students to the off-site location and stored for two or more hours.
- Salmonella and Listeria monocytogenes are potential foodborne pathogen risks associated with foods that are often served in sack lunches.
- Thus, off-site field trips present a food safety challenge for school nutrition programs.

**Purpose**

When held under conditions that simulate temperatures in an enclosed school bus on a warm day, determine the growth potential of Listeria monocytogenes and Salmonella spp. in common school lunch foods packed in insulated coolers, with and without ice packs on the bottom.

**Methods**

- Ambient temperature profiles were determined using data loggers to record internal and external bus temperatures during May-June 2015 in North Carolina and Arkansas.
- Lunches met NSLP standards, and included a turkey sandwich, sliced apples, and baby carrots.
- Lunches inoculated separately with Listeria monocytogenes or Salmonella (ca. 4 log CFU/g; control samples enumerated at time of placement into thermal processing unit).

**Results**

- In coolers packed without ice, all foods were in the temperature danger zone (TDZ; 41-135°F) for five hours.
- 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 TDZ for five hours.

**Applications**

- To meet USDA Food Code standards for cold holding, lunches should be packed in insulated coolers with 2-3 layers of ice or ice packs.
- For field trip lunches, foods unlikely to support microbial growth should be selected.
- Child nutrition professionals should be educated about the importance of time and temperature control during field trips.
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 has been stored and handled properly until serving may be difficult. This may not be the case for other pathogens or food types.

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:

1. cooler packed with one layer of ice packs on the bottom
2. 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.

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 ≤ 0.05*).

This study suggests that time ≤ 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-hour simulation.

- Therefore, storage time (≤5 hr) as a public health control is effective for preventing foodborne pathogen growth on these specific food products.