Journal of Food Protection, Vol. 72, No. 8, 2009, Pages 1692–1698

Tomato Handling Practices in Restaurants†

ELIZABETH KIRKLAND,[1] LAURA R. GREEN,[1]* CARMILY STONE,[2] DAVE REIMANN,[3] DAVE NICHOLAS,[4] RYAN MASON,[5] ROBERTA FRICK,[6] SANDRA COLEMAN,[7] LISA BUSHNELL,[8] HENRY BLADE,[9] VINCENT RADKE,[1] CAROL SELMAN,[1] AND THE EHS-NET WORKING GROUP[1]

[1]National Center for Environmental Health, Centers for Disease Control and Prevention, MS F-28, 4770 Buford Highway, Atlanta, Georgia 30341; [2]Iowa Department of Public Health, Bureau of Environmental Health Services, 321 East 12th Street, Des Moines, Iowa 50319; [3]Minnesota Department of Health, 410 Jackson Street, Suite 500, Mankato, Minnesota 56001; [4]New York State Department of Health, Bureau of Community Environmental Health & Food Protection, 547 River Street, Flanigan Square, Room 515, Troy, New York 12180; [5]Food Division, Metro Public Health Department, 311 23rd Avenue North, Nashville, Tennessee 37203; [6]California Department of Public Health, 850 Marina Bay Parkway, Building P, 1st Floor, Richmond, California 94808; [7]Department of Human Resources, Georgia Division of Public Health, 2 Peachtree Street N.W., 14th Floor, Atlanta, Georgia 30303; [8]Connecticut Department of Public Health, Food Protection Program, Division of Environmental Health, MS #51 FDP, 410 Capitol Avenue, P.O. Box 340308, Hartford, Connecticut 06134-0308; and [9]Office of Food Protection, Rhode Island Department of Health, 3 Capitol Hill, Providence, Rhode Island 02908, USA

MS 08-608: Received 11 December 2008/Accepted 22 March 2009

ABSTRACT

In recent years, multiple outbreaks of *Salmonella* infection have been associated with fresh tomatoes. Investigations have indicated that tomato contamination likely occurred early in the farm-to-consumer chain, although tomato consumption occurred mostly in restaurants. Researchers have hypothesized that tomato handling practices in restaurants may contribute to these outbreaks. However, few empirical data exist on how restaurant workers handle tomatoes. This study was conducted to examine tomato handling practices in restaurants. Members of the Environmental Health Specialists Network (EHS-Net) observed tomato handling practices in 449 restaurants. The data indicated that handling tomatoes appropriately posed a challenge to many restaurants. Produce-only cutting boards were not used on 49% of tomato cutting observations, and gloves were not worn in 36% of tomato cutting observations. Although tomatoes were washed under running water as recommended in most (82%) of the washing observations, tomatoes were soaked in standing water, a practice not recommended by the U.S. Food and Drug Administration (FDA), in 18% of observations, and the temperature differential between the wash water and tomatoes did not meet FDA guidelines in 21% of observations. About half of all batches of cut tomatoes in holding areas were above 41°F (5°C), the temperature recommended by the FDA. The maximum holding time for most (73%) of the cut tomatoes held above 41°F exceeded the FDA recommended holding time of 4 h for unrefrigerated tomatoes (i.e., tomatoes held above 41°F). The information provided by this study can be used to inform efforts to develop interventions and thus prevent tomato-associated illness outbreaks.

In recent years, at least 12 outbreaks of *Salmonella* infection have been associated with fresh tomatoes. These outbreaks have caused approximately 1,990 culture-confirmed illnesses and approximately 75,000 other illnesses *(1, 9)*. These outbreaks have increased in frequency and magnitude over time, many have been multistate, and some have been recurrent *(1)*. These facts indicate that tomato-associated outbreaks of *Salmonella* infection are a significant ongoing problem.

Epidemiologic and environmental investigations of these tomato-associated outbreaks have indicated that the contamination of the tomatoes probably occurred early in the farm-to-consumer chain, such as at the farm or during processing *(1)*. However, in most of these outbreaks, tomato consumption occurred in restaurants. Researchers have hypothesized that tomato handling practices in restaurants may contribute to pathogen proliferation on and cross-contamination from previously contaminated tomatoes. These practices include cutting and pooling large batches of tomatoes for later use and service, potentially allowing cross-contamination from contaminated tomatoes to non-contaminated tomatoes; washing or soaking tomatoes in water colder than the tomatoes, potentially allowing infiltration of contaminants from the outside to the inside of tomatoes; and holding tomatoes at room temperature, potentially causing proliferation of pathogens *(2, 3, 4, 10)*.

Despite these concerns, empirical data on tomato handling practices in restaurants are rare. The purpose of this study was to collect descriptive data on tomato handling practices in restaurants. Specifically, this study was focused on tomato receiving, storing, washing, cutting, and holding practices.

Recently, the U.S. Food and Drug Administration (FDA) amended the 2005 Food Code for retail establishments to include cut tomatoes as a food that requires time and temperature control at 41°F (5°C) or less for safety *(7)*. In 2007, the FDA also released guidance for retail food establishments on storage and handling of fresh tomatoes to prevent contamination of and from tomatoes and to minimize the impact when contamination of tomatoes has

* Author for correspondence. Tel: 770-488-4332; Fax: 770-488-7310; E-mail: lrg0@cdc.gov.

† The contents of this study are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention.

already occurred (e.g., reduce proliferation of pathogens on contaminated tomatoes) *(8)*. These guidance documents were released after the data for this study were collected; however, where appropriate, the data are presented in the context of these guidelines. The guidelines pertinent to this study include the following.

(i) Segregate fresh produce from other refrigerated foods in refrigeration units by using a separate set of storage racks or a separate cooler if possible.

(ii) Always wash whole tomatoes under running potable water before use; do not soak or store tomatoes in standing water.

(iii) Maintain wash water temperature at 10°F (5.5°C) warmer than the produce.

(iv) Consider precut produce ready to eat (with no further need for washing) unless the label says otherwise, because precut produce is washed before processing.

(v) Refrigerate cut tomatoes at 41°F or less to prevent pathogen proliferation because cut tomatoes are considered a potentially hazardous food requiring time and temperature control for safety.

(vi) Cut tomatoes may be held unrefrigerated (i.e., above 41°F) for up to 4 to 6 h under certain conditions (e.g., tomatoes are at 41°F or less when removed from temperature control, unused cut tomatoes are discarded, and temperature is monitored).

Where appropriate, the data from this study are also presented in the context of other FDA guidance, such as the Food Code *(6)*. For example, data are presented on glove use during tomato handling because the Food Code recommends that bare hands should not contact ready-to-eat foods, and glove use is one method for preventing this contact.

MATERIALS AND METHODS

This study was conducted by the Environmental Health Specialists Network (EHS-Net), a network of environmental health specialists focused on the investigation of factors contributing to foodborne illness, including food handling practices. EHS-Net is a collaborative project of the Centers for Disease Control and Prevention (CDC), the FDA, the U.S. Department of Agriculture, and health departments in nine states (California, Connecticut, New York, Georgia, Iowa, Minnesota, Oregon, Rhode Island, and Tennessee).

Sample. The study sample was composed of randomly selected restaurants located in predefined geographical areas of eight EHS-Net states (California, Connecticut, New York, Georgia, Iowa, Minnesota, Rhode Island, and Tennessee). The geographical sites were determined primarily by convenience and included selected counties within the eight states (California: Alameda and Contra Costa; Connecticut: Fairfield and Middlesex; Georgia: Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Newton, Paulding, Pickens, Rockdale, Spalding, and Walton; Iowa: Boone, Dallas, Polk, Jasper, and Warren; Minnesota: Blue Earth, Carver, Dakota, Scott, and Steele; New York: Albany, Clinton, Columbia, Delaware, Essex, Franklin, Fulton, Greene, Hamilton, Montgomery, Otsego, Rensselaer, Saratoga, Schenectady, Schoharie, Warren, and Washington; Rhode Island: all counties; Tennessee: Cheatham, Dickson, Houston, Humphreys, Montgomery, Robertson, Rutherford, Sumner, Stewart, Trousdale, Williamson, Wilson, and Davidson).

At each EHS-Net site, data were collected in approximately 50 restaurants. Restaurants that did not serve raw fresh tomatoes were excluded from the study, as were restaurants that did not meet the EHS-Net definition of a restaurant (establishments that prepare and serve food or beverages to customers but that are not institutions, food carts, mobile food units, temporary food stands, supermarkets, restaurants in supermarkets, or caterers). Only one restaurant from a regional or national chain was included per EHS-Net site.

Data collection. Data were collected from March through September 2006. The study protocol was cleared by the CDC Institutional Review Board and the appropriate institutional review boards in the participating states. All data collectors (EHS-Net environmental health specialists) participated in training designed to increase data collection consistency.

To solicit restaurant participation, data collectors contacted restaurants by telephone using a standardized recruiting script. Visits to participating restaurants were scheduled to coincide with times when tomato preparation would occur. Once on site, data collectors interviewed the manager about restaurant characteristics, tomato handling practices, and the manager's perceptions of the foodborne illness risk associated with improperly prepared cut tomatoes (rating scale: 1, very little risk; 5, great deal of risk). Data collectors recorded observation data on any raw fresh tomatoes (or tomato products) in receiving, storage, and holding and on any raw fresh tomatoes being washed or cut during the visit. During these observations, data collectors recorded ambient temperatures of tomato receiving and storage locations and temperatures of tomatoes in receiving and storage, being soaked during washing, immediately after cutting, and in holding areas. To obtain a temperature for whole tomato batches, a thermometer was inserted into one whole tomato. To obtain a temperature for cut tomato batches, a thermometer was inserted into the center of the batch. Data collectors also interviewed restaurant workers about how long tomatoes in storage and holding areas had been and would be held. Multiple observations of tomatoes were made per restaurant depending on the number of tomato types used and the preparation activities occurring at the time of the visit. At the end of the visit, an FDA tomato handling fact sheet was given to the interviewed manager.

Data analysis. Descriptive statistics (frequencies and medians) were obtained with the SPSS version 12 software package. We attempted to disaggregate the data for precut tomatoes (tomatoes that were cut before being packaged and delivered to the restaurants) and whole tomatoes, but the low frequency of precut tomatoes observed precluded this analysis for all tomato handling practices except storage. Because of missing data, denominators differ across analyses and thus are provided for all analyses.

RESULTS

Restaurant demographics. Of the 1,222 restaurants we contacted, 604 were eligible to participate in the study. Of these, 453 agreed to participate, yielding a response rate of 73%. Because of missing information, data are reported for only 449 restaurants. According to interviewed managers, 62.8% (282 of 449) of restaurants were independently owned and 37.9% (167 of 449) were chains or franchises.

About one-third of restaurants (34.7%, 152 of 437) reported serving 1 to 100 meals per day, 44.4% (194 of 437) reported serving 100 to 300 meals per day, and 21.3% (93 of 437) reported serving more than 300 meals per day.

Managers' perceptions of foodborne illness risk associated with improperly prepared tomatoes. Managers perceived improperly prepared cut tomatoes ($M = 3.0$) as posing significantly less foodborne illness risk than improperly prepared fried chicken ($M = 4.1$), smoked fish ($M = 3.7$), roast beef ($M = 3.9$), roast pork ($M = 4.1$), and green onions ($M = 3.1$) ($ts > 2.2$, $P < 0.03$, $n = 379$). Managers perceived improperly prepared cut tomatoes as posing significantly more foodborne illness risk than improperly prepared cut lettuce ($M = 2.9$), french bread ($M = 2.1$), and baked potatoes ($M = 2.7$) ($ts > 2.1$, $P < 0.03$, $n = 379$). There were no significant differences in perceived foodborne illness risk between cut tomatoes and fresh berries ($M = 3.0$) and cut melons ($M = 3.0$) ($ts < 1.6$, $P > 0.13$, $n = 379$).

General tomato practices. According to managers, 89.2% (399 of 447) of restaurants served round tomatoes, 18.3% (82 of 447) served Roma tomatoes, 28.6% (128 of 447) served grape or cherry tomatoes, and 1.8% (8 of 447) served some other type of tomato; 6.3% (28 of 447) of restaurants served precut tomatoes. Managers reported that tomatoes were most often used in salads (88.9%, 399 of 449 restaurants) followed by sandwiches (80.0%, 359 of 449), hamburgers (51.7%, 232 of 449), wraps (34.0%, 153 of 449), other menu items (23.1%, 104 of 449), and salsa (15.6%, 70 of 449). About three-quarters of the managers (74.1%, 330 of 445) reported that they had received training or instructions on produce safety or handling, and 85.9% (378 of 440) reported that food workers in their restaurant had received such training. Half of the managers (50.3%; 226 of 449) reported that their restaurant had a separate produce preparation area, and 73.6% (326 of 443) reported that single-use gloves were used during tomato preparation.

Tomato receiving. According to manager self-reports, 46.7% (187 of 400) of restaurants received prewashed (defined as having been labeled as prewashed by the supplier) tomatoes. Manager interview data also indicated that 45.6% (204 of 447) of restaurants received tomatoes from produce distributors, followed by general distributors (38.7%, 173 of 447), grocery stores (11.4%, 51 of 447), produce markets (7.8%, 35 of 447), corporate distributors (7.4%, 33 of 447), and other types of distributors (4.9%, 22 of 447). The median number of tomato shipments per week reported by managers was two (25th percentile = 1.0, 75th percentile = 3.0, $n = 434$) with a median average of 25.0 lb (11.4 kg) per shipment (25th percentile = 15.0 lb [6.8 kg], 75th percentile = 40.0 lb [18.2 kg], $n = 424$). Manager interview data also indicated that immediately upon delivery, tomatoes were placed directly into the storage location (e.g., walk-in cooler, dry storage) in 73.3% (329 of 449) of restaurants, tomatoes were placed somewhere other than the storage location (e.g., general kitchen area) in 24.3% (109 of 449) of restaurants, and tomatoes were placed outside the establishment (e.g., a loading dock) in 2.7% (12 of 449) of restaurants. When tomato shipments were not placed immediately into storage, 30 min (25th percentile = 10.2 min, 75th percentile = 60.0 min, $n = 120$) was the median manager estimate of the average amount of time the shipments remained in place before they were moved to storage or used to prepare a menu item.

In 5.1% (23 of 449) of restaurants, data collectors observed a tomato shipment awaiting movement from delivery location to storage. These shipments were all of whole tomatoes. The median ambient temperature in the tomato shipment location was 66.0°F (19.2°C) (25th percentile = 63.0°F [17.2°C], 75th percentile = 72.0°F [22.2°C], $n = 449$), and the median temperature of one tomato in the shipment was 57.0°F (13.8°C) (25th percentile = 49.0°F [9.4°C], 75th percentile = 65.0°F [18.3°C], $n = 449$).

Tomato storage. Manager interview data indicated that most restaurants stored tomatoes before preparation in general coolers (87.5%, 393 of 449) followed by ambient temperature storage areas (10.9%, 49 of 449), produce coolers (5.6%, 25 of 449), and other storage locations (0.7%, 3 of 449). Data collectors observed one to three tomato types in storage in 99.8% (448 of 449) of restaurants, for a total of 563 storage observations. Most of these observations (95.6%, 538 of 563) were of whole tomatoes. Most tomatoes were stored in general coolers (81.7%, 460 of 563), and the rest were stored in ambient temperature storage areas (10.5%, 59 of 563) and produce coolers (7.8%, 44 of 563). Table 1 contains time and temperature data on these tomatoes by storage location. The median storage location temperature was 40.0°F (4.4°C). This median temperature varied by location, with ambient temperature storage areas having the highest median temperature. The storage location temperature was above 41°F in 37.2% of storage observations. This percentage of observations differed by location, with the highest percentage of observations of higher temperatures in ambient temperature storage areas. The median tomato temperature was 40.0°F and differed by location; tomatoes in ambient temperature storage areas again had the highest median temperature. The internal tomato temperature was above 41°F in 45.6% of storage observations. This percentage differed by storage location, with ambient temperature storage areas having the highest percentage of observations above 41°F. According to interview data, before being used to prepare a menu item, tomatoes were stored for a median of 48 h. This median time differed by location, with tomatoes stored for the longest times in general and produce coolers.

Precut tomatoes were observed in general coolers (8.0%, 2 of 25 observations) and produce coolers (92.0%, 23 of 25) but not in ambient temperature storage areas; whole tomatoes were observed in all three locations (general coolers: 81.2%, 437 of 538 observations; produce coolers:

TABLE 1. *Tomato temperatures, location temperatures, and average storage time for tomatoes in storage*

Location	Storage location temp (°F)[a]				Storage location temp >41°F		Tomato temp (°F)[a]				Tomato temp >41°F		Avg tomato storage time (h)[b]			
	Median	25th percentile	75th percentile	Total *n*	%	*n*	Median	25th percentile	75th percentile	Total *n*	%	*n*	Median	25th percentile	75th percentile	Total *n*
General coolers	39.0	37.0	42.0	456	29.6	135	40.0	38.0	43.0	453	37.5	170	48.0	24.0	72.0	439
Produce coolers	40.0	36.0	43.8	44	31.8	14	42.0	38.0	45.5	41	56.1	23	48.0	24.0	54.0	41
Ambient storage	69.0	65.0	75.0	59	100.0	59	68.0	61.0	75.0	58	100.0	58	24.0	12.0	36.0	56
All	40.0	37.0	44.0	559	37.2	208	41.0	38.0	45.0	552	45.6	251	48.0	24.0	72.0	536

[a] To convert degrees Fahrenheit to degrees Celsius, subtract 32, multiply by 5, and divide by 9.
[b] Data obtained through interview.

7.8%, 42 of 538; ambient temperature storage areas: 11.0%, 59 of 538). The median temperature of precut tomato storage locations was 37.0°F (2.8°C) (25th percentile = 35.0°F [1.7°C], 75th percentile = 41.8°F [5.4°C], $n = 24$); the median temperature of whole tomato storage locations was 40.0°F (25th percentile = 38.0°F, 75th percentile = 44.0°F [6.7°C], $n = 535$). The storage location temperature was above 41°F in 25.0% (6 of 24) of precut tomato observations and in 37.8% (202 of 535) of whole tomato observations. The median internal temperature of precut tomatoes was 38.5°F (3.6°C) (25th percentile = 36.0°F [2.2°C], 75th percentile = 42.8°F [6.0°C], $n = 20$); the median internal temperature of whole tomatoes was 41.0°F (25th percentile = 38.0° F, 75th percentile = 45.0°F [7.2°C], $n = 532$). The internal tomato temperature was above 41°F in 30.0% (6 of 20) of precut tomato observations and in 46.1% (245 of 532) of whole tomato observations. According to interview data, before being used to prepare a menu item precut and whole tomatoes were both stored for a median of 48 h (precut tomatoes: 25th percentile = 48 h, 75th percentile = 72 h, $n = 23$; whole tomatoes: 25th percentile = 24 h, 75th percentile = 72 h, $n = 513$).

Tomato washing. Most of the managers (95.3%, 427 of 448) reported that in their restaurant tomatoes were washed before preparation. Manager interview data also indicated that during washing, water temperature was monitored in 1.6% (7 of 427) of restaurants, tomato temperature was monitored in 3.0% (13 of 427) of restaurants, and produce-cleaning chemicals were used during washing in 5.1% (22 of 427) of restaurants.

Data collectors observed one to three tomato types being washed in 86.8% (390 of 449) of restaurants, for a total of 483 washing observations. Most of these washing observations (99.4%, 480 of 483) were of whole tomatoes. Tomatoes were washed most frequently in multiuse sinks (64.2%, 298 of 464), followed by produce-only sinks (30.4%, 141 of 464), containers (6.5%, 30 of 464), hand sinks (4.1%, 19 of 464), utility sinks (0.6%, 3 of 464), raw-animal-product-only sinks (0.4%, 2 of 464), and other types of sinks (0.4%, 2 of 464). Chemicals (e.g., chlorine solutions and commercial produce washes) were used in 5.5% (26 of 471) of observations, and soap was used in 0.2% (1 of 471) of observations. The most frequent washing method was rinsing or holding under running water (82.0%, 386 of 471 observations), followed by soaking (18.0%, 85 of 471).

Tomatoes were soaked for a median of 3 min (25th percentile = 0.75 min, 75th percentile 6.0 min, $n = 81$). In 27.1% of soaking observations (23 of 85), at least one tomato had torn or broken skin. The median temperature of the soaking water was 65.0°F (25th percentile = 57.3°F [14.1°C], 75th percentile = 73.0°F [22.8°C], $n = 76$), and the median internal temperature of each observed batch of tomatoes was 41.0°F (25th percentile = 38.0°F, 75th percentile = 49.2°F [9.6°C], $n = 76$). The median temperature difference between the water and the tomatoes was 20.0°F (11°C) (25th percentile = 11.0°F [6.1°C]; 75th

percentile = 28.8°F [16°C], n = 76). In 21% (16 of 76) of soaking observations, the water was not at least 10°F warmer than the tomatoes, as recommended by the FDA. In 62.5% (10 of 16) of these observations, the water was warmer but not 10°F warmer than the tomatoes, and in 37.5% (6 of 16) of these observations, the water was colder than the tomatoes.

Tomato cutting. Most of the managers (93.1%, 418 of 449) reported that tomatoes were cut, sliced, or diced in their restaurant. Manager interview data also indicated that knives and cutting boards were used to cut tomatoes in 80.6% (337 of 418) of restaurants, and other tools (e.g., slicers) were used in 42.3% (177 of 418) of restaurants.

Data collectors observed one to three tomato types being cut in 89.4% (407 of 449) of restaurants, for a total of 455 cutting observations. Most of these observations (99.3%, 452 of 455) were of whole tomatoes. In 79.0% (354 of 448) of these observations, a knife and cutting board were used, and in 50.7% (173 of 341) of these observations, produce- or tomato-only cutting boards were used. In 40.0% (169 of 423) of cutting observations, other kitchen tools (e.g., slicers or blenders) were used. In 74.0% (125) of the 169 observations in which other kitchen tools were used, the tools were manual, and in 31.4% (53 of 169) of these observations, the tools were electric. In 63.8% (287 of 450) of observations, single-use gloves were worn during cutting. The median temperature of the tomato batches immediately after cutting was 49.0°F (25th percentile = 44.0°F, 75th percentile = 55.0°F [12.8°C], n = 447). In 88.3% (395 of 447) of cutting observations, the temperature of the cut tomatoes was above 41°F, the FDA recommended maximum temperature for held cut tomatoes.

Holding of cut tomatoes. Data collectors observed 1 to 20 batches of previously prepared tomatoes or food items containing tomatoes in holding in 66.6% (299) of restaurants, for a total of 552 holding observations. These batches were most frequently found at made-to-order stations (51.0%, 282 of 552), followed by reach-in coolers (23.0%, 127 of 552), walk-in coolers (14.9%, 82 of 552), ready-to-eat locations (5.6%, 31 of 552), buffets and salad bars (2.7%, 15 of 552), and dry storage areas (2.7%, 15 of 552) (see Table 2 for definitions of these locations).

Eighty-three percent (458) of these observations (in 61.5% [276] of restaurants) were of cut tomatoes or food items that included cut tomatoes. Table 2 contains time and temperature data on these cut tomato batches by holding location. The median temperature of these batches was 42.0°F (5.6°C). Fifty-two percent of these batches were above 41°F. The cut tomatoes had been in the holding area for a median of 4.0 h, as reported by food workers. The median maximum time cut tomatoes were held, as reported by food workers, was 12.0 h.

The percentage of cut tomato batches held above 41°F differed by holding location, with the largest percentage in dry storage areas and the smallest percentage in walk-in coolers. Median current and maximum holding hours, obtained through interview, also differed by location, with

TABLE 2. *Holding temperatures and time for cut tomatoes*

Location[a]	Product temp (°F)[b]				Product temp >41°F		Product time in location (h)				Product maximum time in location (h)[c]			
	Median	25th percentile	75th percentile	Total n	%	n	Median	25th percentile	75th percentile	Total n	Median	25th percentile	75th percentile	Total n
Ready to eat	43.5	38.3	46.8	20	55.0	11	3.0	1.0	10.4	20	7.5	2.0	16.6	20
Made to order	43.0	39.0	48.3	238	59.2	141	4.0	2.0	15.0	237	10.3	5.0	24.0	236
Buffet or salad bar	45.0	41.5	46.3	6	83.3	5	1.3	0.6	3.0	9	4.0	1.8	8.5	9
Walk-in	39.0	37.0	42.0	68	32.4	22	10.0	2.5	24.0	69	24.0	12.0	48.0	68
Reach-in	40.0	37.0	45.0	99	43.4	43	5.0	2.0	23.6	98	22.0	6.0	33.0	97
Dry storage	55.0	51.6	58.0	8	100.0	8	0.4	0.3	0.7	8	2.0	2.0	3.5	7
All	42.0	38.0	47.0	439	52.4	230	4.0	2.0	18.0	441	12.0	5.0	24.0	437

[a] Ready to eat, a piece of equipment used to store prewrapped foods that can be eaten without further preparation; made to order, station designed with a refrigerated open top or open condiment rail (including refrigerated sandwich units and pizza preparation tables); buffet or salad bar, designed to receive refrigerated food and maintain food product temperatures (intended for customer self-service); walk-in, cooler room designed to maintain cold storage of nonfrozen foods for periods longer than nonfrozen foods stored in reach-in coolers; reach-in, cooler designed for cold storage of nonfrozen foods between periods of preparation, service, and handling—also known as a day cooler or day refrigerator (foods stored in this type of cooler are intended to be used relatively quickly); dry storage, any nonrefrigerated area used to store food items that do not require refrigeration or freezing.

[b] To convert degrees Fahrenheit to degrees Celsius, subtract 32, multiply by 5, and divide by 9.

[c] Data obtained through interview.

TABLE 3. *Cut tomatoes held above 41°F (5°C) for more than 4 h*

Location[a]	Tomato batches held >4 h[b]		
	%	*n*	Total *n*
Ready to eat	50.0	5	10
Made to order	75.9	101	133
Buffet or salad bar	50.0	3	6
Walk-in	71.4	15	21
Reach-in	86.0	37	43
Dry storage	14.3	1	7
All	73.6	162	220

[a] Ready to eat, a piece of equipment used to store prewrapped foods that can be eaten without further preparation; made to order, station designed with a refrigerated open top or open condiment rail (including refrigerated sandwich units and pizza preparation tables); buffet or salad bar, designed to receive refrigerated food and maintain food product temperatures (intended for customer self-service); walk-in, cooler room designed to maintain cold storage of nonfrozen foods for periods longer than nonfrozen foods stored in reach-in coolers; reach-in, cooler designed for cold storage of nonfrozen foods between periods of preparation, service, and handling—also known as a day cooler or day refrigerator (foods stored in this type of cooler are intended to be used relatively quickly); dry storage, any nonrefrigerated area used to store food items that do not require refrigeration or freezing.

[b] Data obtained through interview.

tomatoes being held the shortest time in dry storage areas and the longest time in walk-in coolers.

Table 3 contains interview data on the percentage of cut tomato batches held above 41°F with maximum holding times of more than 4 h, the maximum FDA-recommended holding time for unrefrigerated cut tomatoes. Seventy-four percent of cut tomato batches held above 41°F had a maximum holding time of more than 4 h. The percentage of tomatoes held for more than 4 h differed by holding location, with the largest percentage in reach-in coolers (86.0%) and the smallest percentage in dry storage areas (14.3%).

DISCUSSION

This study provides valuable insight into tomato handling practices in restaurants. The data revealed several potential opportunities for pathogen cross-contamination and proliferation. Observations revealed that several tomato handling practices did not meet FDA recommendations.

The FDA recommends that to prevent cross-contamination, retail establishments must segregate fresh produce, including tomatoes, from other foods in refrigeration units by using a separate set of storage racks or a separate cooler. Although we did not determine the frequency with which separate racks were used for produce storage, we did determine that separate coolers for produce storage were relatively rare. However, separate coolers require space and resources that separate racks do not; thus, separate racks may be used more frequently than separate coolers.

Although the FDA has not made a specific recommendation about separate areas for preparation of fresh produce, having separate preparation areas would help to prevent cross-contamination to and from tomatoes. Half of the restaurants surveyed reported having such separate preparation areas. The use of produce- or tomato-only cutting boards and gloves during preparation of ready-to-eat food (i.e., tomato cutting), practices that are recommended by the FDA for the prevention of cross-contamination, was recorded in 51 and 64% of cutting observations, respectively. These data indicate that many but not all restaurants are engaging in tomato handling practices designed to prevent cross-contamination.

Although the majority of whole tomato batches were washed under running water, in line with FDA recommendations, 18% of the batches were soaked in standing water, a practice the FDA does not recommend because pathogens can be transferred from tomato to tomato through the water. In 21% of soaking observations, the water was not at least 10°F warmer than the tomatoes, and in 27% of soaking observations, tomatoes with torn or broken skin were soaked. These two practices (inappropriate water-tomato temperature differentials and soaking tomatoes with torn skin) are not recommended by the FDA because they can permit infiltration of contaminants to the inside of the tomatoes *(10)*. In 6% of washing observations, tomatoes were washed in inappropriate sinks, such as hand, utility, and raw-animal-product-only sinks. Although this percentage is relatively small, washing tomatoes in these types of sinks poses an unacceptable risk of contamination. In most restaurants, the temperature of the water or tomatoes was not monitored during washing, indicating an inability to determine compliance with FDA guidelines.

About half of all batches of cut tomatoes in holding areas were above the maximum temperature recommended by the FDA to prevent pathogen proliferation, i.e., 41°F. This finding is perhaps not surprising given that many tomatoes were above this temperature at previous stages: receiving, storage, and holding after cutting. After cutting, 92% of tomato batches were above 41°F. When tomatoes are substantially above 41°F before being placed in a holding area, it is difficult to quickly obtain a holding temperature of 41°F without the use of specialized equipment. If the cut tomatoes were used or discarded within the FDA's recommended holding time of 4 h, these temperatures would not be considered problematic (assuming the tomatoes also met the other conditions for unrefrigerated holding). However, the reported maximum holding time for most (74%) of the cut tomato batches held above 41°F exceeded 4 h.

Overall, our data indicate that many restaurants were not meeting FDA tomato handling guidelines and were thus engaging in practices that could contribute to cross-contamination and pathogen proliferation. However, the FDA's classification of cut tomatoes as a potentially hazardous food and the release of FDA guidelines for food service storage and handling of tomatoes occurred after data collection for this study was completed. Thus, the restaurants in this survey may have been unaware of these guidelines, and it would be unreasonable to expect these data to reflect compliance with these guidelines. Instead, we

should consider these data as a baseline for tomato handling practices and perceptions of foodborne illness risk posed by tomatoes, before any intervention. These data could be quite useful for guiding the development of interventions designed to improve tomato handling practices is restaurants.

Of particular concern are the findings on the lack of time and temperature control of held cut tomatoes. These findings may, in part, result from the restaurant industry's lack of knowledge about the relatively new status of cut tomatoes as a potentially hazardous food and of the new FDA tomato handling guidelines. Although managers perceived cut tomatoes as posing about the same foodborne illness risk as berries and cut melons, they perceived them as posing significantly less risk than more well known potentially hazardous foods, such as meat and poultry. However, the high percentage of cut tomatoes held above 41°F may also result from the difficulty of attempting to lower cut tomato temperatures to 41°F in holding areas when temperatures were above 41°F before holding. To address this issue, restaurants may need to focus on time and temperature controls for whole tomatoes at receiving, in storage, and during preparation. Currently, the FDA does not have recommendations concerning the temperature at which whole tomatoes should be received, stored, and prepared. However, the tomato industry recommends that whole tomatoes be stored at between 50 and 60°F (10 and 15.6°C) for best flavor *(5)*. The restaurant industry may wish to explore storage of whole tomatoes under refrigeration immediately upon receipt and monitoring of temperatures during storage, so that after the tomatoes are cut, their temperature will be closer to the recommended 41°F. Alternatively, given the quality concerns associated with refrigerated tomatoes, the industry may wish to focus on improving its use of time as a public health control for cut tomatoes.

A limitation of this study is that some of the data on tomato handling practices, primarily how long tomatoes were stored and held, were reported by managers or workers rather than observed by our data collectors. Self-report data such as these are susceptible to overreporting of desirable behaviors, such as safe food handling practices. Chain restaurants probably were underrepresented in our sample, because we included only one restaurant from each regional or national chain per EHS-Net site.

This study has contributed valuable information on how restaurants handle tomatoes. This information may contribute to the development of intervention efforts in restaurants and subsequent prevention of tomato-associated outbreaks. For example, environmental health specialists can use this information to support the restaurant industry in improving tomato handling practices. During their inspections and environmental assessments, environmental health specialists can educate restaurant managers and workers about the classification of cut tomatoes as potentially hazardous, look for some of the specific inappropriate tomato handling practices identified in this study, and assist restaurant managers and workers in correcting those practices.

ACKNOWLEDGMENTS

We thank Jack Guzewich and Shirley Bohm (FDA) for their assistance with study design and data interpretation. This study was supported by states receiving CDC grant awards funded under CDC-RFA-EH05-013.

REFERENCES

1. Centers for Disease Control and Prevention. 2007. Multistate outbreaks of *Salmonella* infections associated with raw tomatoes eaten in restaurants—United States, 2005–2006. *Morb. Mortal. Wkly. Rep.* 56:909–911.
2. Cumming, K., E. Barrett, J. Mohle-Boetani, J. Brooks, J. Farrar, T. Hunt, A. Fiore, K. Komatsu, S. Benson Werner, and L. Slutsker. 2001. A multistate outbreak of *Salmonella enterica* serotype Balidon associated with domestic raw tomatoes. *Emerg. Infect. Dis.* 7:1046–1048.
3. Gupta, S. K., K. Nalluswami, C. Snider, M. Perch, M. Balasegaram, D. Burmeister, J. Lockett, C. Sandt, R. Hoekstra, and S. Montgomery. 2007. Outbreak of *Salmonella* Braenderup infections associated with Roma tomatoes, northeastern United States, 2004: a useful method for subtyping exposures in field investigations. *Epidemiol. Infect.* 135:1165–1173.
4. Hedberg, C., F. Angulo, K. White, C. Langkop, W. Schell, M. Stobierski, A. Schuchat, J. Besser, S. Dietrich, L. Helsel, P. Griffin, J. McFarland, M. Osterholm, and the Investigation Team. 1999. Outbreaks of salmonellosis associated with eating uncooked tomatoes: implications for public health. *Epidemiol. Infect.* 122: 385–393.
5. North American Tomato Trade Work Group. 2006. Commodity specific food safety guidelines for the fresh tomato supply chain. Available at: http://www.cfsan.fda.gov/~acrobat/tomatsup.pdf. Accessed 26 August 2008.
6. U.S. Food and Drug Administration. 2005. Food Code. Available at: http://www.cfsan.fda.gov/~dms/fc05-toc.html. Accessed 26 August 2008.
7. U.S. Food and Drug Administration. 2007. Supplement to the 2005 FDA Food Code. Available at: http://www.cfsan.fda.gov/~dms/fc05-sup.html. Accessed 26 August 2008.
8. U.S. Food and Drug Administration. 2007. Program information manual: retail food protection: storage and handling of tomatoes. Available at: http://www.cfsan.fda.gov/~ear/pimtomat.html#quest. Accessed 26 August 2008.
9. Voetsch, A., T. Van Gilder, F. Angulo, M. Farley, S. Shallow, R. Marcus, P. Cieslak, V. Deneen, and R. Tauxe, for the Emerging Infections Program FoodNet Working Group. 2004. FoodNet estimate of the burden of illness caused by nontyphoidal *Salmonella* infections in the United States. *Clin. Infect. Dis.* (Suppl. 3):S127–S134.
10. Zhuang, R.-Y., L. R. Beuchat, and F. J. Angulo. 1995. Fate of *Salmonella* Montevideo on and in raw tomatoes as affected by temperature and treatment with chlorine. *Appl. Environ. Microbiol.* 61:2127–2131.