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**Program Information Manual: Retail Food Protection Storage and Handling of Tomatoes**

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**Questions**

- Are tomatoes potentially hazardous food requiring time/temperature control for safety?
- How should fresh whole tomatoes, cut fresh tomatoes and cut fresh tomatoes used as an ingredient in other foods (i.e., in salsa, in salads, topping a pizza, in sandwiches, etc.) be handled in a retail food establishment?

**Discussion and Rationale**

Recent foodborne illness outbreaks associated with tomatoes indicate the storage and handling practices of tomatoes and other fresh produce in food service operations and retail food stores must be re-examined. The FDA's Produce Safety Action Plan (6) recommended adding language to the Food Code to address produce safety at retail. The Conference for Food Protection (CFP) in 2006 recommended to FDA (2) to incorporate "cut tomatoes" into the definition of potentially hazardous food (time/temperature control for safety food) in the FDA Food Code (5).

A potentially hazardous food (PHF) or time/temperature control for safety food (TCS food) is defined in terms of whether or not it requires time/temperature control for safety to limit pathogen growth or toxin formation. The term does not include foods that do not support growth whether or not they contain a pathogenic microorganism or chemical or physical food safety hazard. The progressive growth of all foodborne pathogens is considered whether slow or rapid. This definition takes into consideration a food's acidity (pH), water activity ( $a_w$ ), or combination of pH and  $a_w$  interaction, heat treatment, and packaging for a relatively simple determination of whether the food requires time/temperature control for safety. (See [Attachment A](#))

When pH and/or  $a_w$  are not sufficient to control pathogen growth and/or toxin formation in the food, refrigeration may be the only viable alternative without changing the character of the food. Internal FDA research (see [Attachment B](#)) and other published references (1, 7, 9, 10, 11) have shown that the pH (4.2 - 4.8),  $a_w$  (0.99) and available nutrients of cut fresh tomatoes support the growth of *Salmonella* spp., the pathogen of concern for cut fresh tomatoes. While the pH and  $a_w$  of various varieties of tomato may vary somewhat (1) these values are still within the growth range of *Salmonella*. Therefore, cut tomatoes are considered a PHF (TCS food) because they support the growth of foodborne pathogens.

Historically, most fruits and vegetables have been considered non-PHF (non-TCS food) unless they were epidemiologically implicated in foodborne outbreaks. Since 1990, at least 12 large, multi-state foodborne outbreaks as well as small local outbreaks have been associated with different varieties of tomatoes (2, 3, 6). From 1998 - 2006, outbreaks reported to FDA associated with tomatoes made up 17% of the produce-related outbreaks. *Salmonella* has been the pathogen of concern most often associated with tomato outbreaks. Natural reservoirs for *Salmonella* spp. include birds, amphibians, reptiles, soil, pond sediment as well as infected and recovering human beings. *Salmonella* is viable in the environment (in soil, water, etc.) for months (5).

Biofilm formation by *Salmonella* allows bacterial cells to survive under adverse environmental conditions and also reduces the ability to remove pathogens by washing even with antimicrobial agents (7, 9). Once a *Salmonella* cell attaches to a surface such as the tomato skin, after 60-90 minutes it begins to secrete fibers of polysaccharide forming a biofilm in about 10 hrs. It can survive on tomatoes and does not die off during transportation, ripening and storage. The ability to fully decontaminate tomatoes is limited once they have become contaminated and the *Salmonella* cells have attached to the surface. Whole intact tomatoes with their protective waxy cuticle and low water activity on the surface do not support the growth of foodborne pathogens on the surface of the tomato.

*Salmonella* spp. can be carried by irrigation water, water flumes or wash water and has also been shown experimentally to enter the tomato plant and fruit through several different routes

including through the flower, root, stem scar and cracks, cuts or bruises in the skin (5). Infiltration of microorganisms is also associated with negative temperature differentials between water and the tomato flesh. The temperature of wash water should be at least 10°F warmer than the tomato temperature to prevent infiltration. Cold water causes air cells in the tomato to contract and create a vacuum drawing water into the tomato. Contamination in water or on equipment can include bacteria, viruses, parasites and fungi such as molds and yeasts. In addition to spoilage, fungal contamination can raise the pH of the tomato and improve conditions for growth of foodborne pathogens (11). Once inside the tomato, bacterial pathogens cannot be removed by washing or sanitizing solutions, which in any case can only reduce pathogen levels 1-2 logs.

Other sources of contamination of tomatoes include storing or transporting the tomatoes under conditions subject to cross-contamination from other foods, especially raw meat or poultry. It includes use of dirty equipment and utensils that come in contact with the tomatoes such as dirty sinks or pans for washing, dirty cutting boards, dirty knives, slicers, choppers, etc (8). It also includes no or inadequate handwashing by food employees and ill food employees with symptoms of vomiting, diarrhea or jaundice or a diagnosis of foodborne illness who continue to work with food.

## Recommendation

The following recommendations are based on provisions of the 2005 FDA Food Code and the 2006 CFP recommendation to add "cut tomatoes" (e.g., sliced, diced) to the definition of PHF/TCS food in the 2007 Supplement to the 2005 FDA Food Code. They are being offered to prevent contamination in food service facilities and retail food stores and to minimize the impact when contamination of fresh tomatoes has already occurred (regardless of the location where the contamination occurred).

- Cut tomatoes should be considered PHF (TCS food) according to Interaction Table B in the definition of PHF (TCS food) in the 2005 FDA Food Code in Paragraph 1-201.10(B) and internal FDA research (See [Attachment B](#)) and therefore require refrigeration at 5°C (41°F) or less.
- Cut tomatoes used as an ingredient in another food will make that food PHF (TCS food) unless it is acidified or altered in some way to make the cut tomatoes non-PHF (non-TCS food). Example foods to consider:
  - Salsa with chopped tomatoes acidified with vinegar, lemon juice or lime juice to give a pH below 4.2 is non-PHF (non-TCS food). Salsa with cut tomatoes and without sufficient acidifying agent (acidulant) to give a pH below 4.2 is PHF (TCS food) and requires refrigeration at 41°F or less.
  - Chopped, sliced or cut tomatoes in a vinegar or lemon juice-based dressing so that the pH is less than 4.2 is considered non-PHF (non-TCS food) and does not require refrigeration.
  - Chopped, sliced or cut tomatoes with lettuce or other leafy greens in a salad without sufficient acidifying agent so the pH is less than 4.2 is considered PHF (TCS food) and requires refrigeration.
  - Chopped, sliced or cut up tomatoes in all sandwiches, on top of a pizza (with raw or cooked crust or dough) or added to any ready-to-eat food is considered PHF (TCS food) and requires refrigeration or other forms of time/temperature control.
- The food safety practices in Attachment C, "[Recommendations for Food Establishments Serving or Selling Fresh Tomatoes](#)" are recommended to prevent contamination and minimize the impact when contamination of fresh tomatoes occurs (regardless of the location where the contamination occurred), based on the 2005 FDA Food Code and 2007 Supplement to the FDA Food Code.

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## ATTACHMENT A

### Definition of Potentially Hazardous Food (Time/Temperature Control for Safety Food)

#### taken from the 2005 FDA Food Code, Section 1-201.10(B)

**Table B. Interaction of pH and  $a_w$  for control of vegetative cells and spores in food not heat-treated or heat-treated but not packaged.**

$a_w$ values	pH values			
	< 4.2	4.2 - 4.6	> 4.6 - 5.0	> 5.0
< 0.88	non-PHF*/non-TCS food**	non-PHF/non-TCS food	non-PHF/non-TCS food	non-PHF/non-TCS food
0.88 - 0.90	non-PHF/non-TCS food	non-PHF/non-TCS food	non-PHF/non-TCS food	PA***
> 0.90 - 0.92	non-PHF/non-TCS food	non-PHF/non-TCS food	PA	PA
> 0.92	non-PHF/non-TCS food	PA	PA	PA
* PHF means Potentially Hazardous Food ** TCS food means Time/Temperature Control for Safety food *** PA means Product Assessment required				

## ATTACHMENT B

### Growth of *Salmonella* spp. in Beefsteak and Roma Tomatoes at Room (72°F) and Refrigeration Temperature (41°F).

The 2005 version of the FDA Food Code defines Potentially Hazardous Food (PHF) as any food that requires time/temperature control for safety (TCS) to limit pathogenic microorganisms growth or toxin formation. As part of the recommendations following revision of the definition, a series of experiments was designed to determine if cut tomatoes need to be classified under the PHF/TCS Food category. In the last decade various *Salmonella* spp. outbreaks have been linked to consumption of cut tomatoes, which raises the question of whether fresh tomatoes should be refrigerated for safety.

In the FDA experiments, *Salmonella enterica* serovar Enteritidis and serovar Newport were grown in Beefsteak and Roma tomatoes at 72°F and 41°F to determine if growth occurs during a 24-hour time period.

#### Methodology

**Bacterial strain.** *Salmonella* Enteritidis and S. Newport (mango outbreak and tomato outbreak strains) were obtained from the Food and Drug Administration's culture collections.

**pH and Water Activity ( $a_w$ ).** Measurements for pH and  $a_w$  were performed on blended tomatoes.

**Growth Curves.** Beefsteak and Roma tomatoes were purchased from a local grocery store as well as from a restaurant supplier and used for the experiments. In repetitions 1 through 4, tomatoes were purchased from a grocery store and for repetition 5, tomatoes were from a restaurant supplier. In all cases, the ambient temperature tomatoes were sliced or blended the day prior to the experiment and stored at 41°F overnight until inoculation the next morning. Cut and blended tomatoes were inoculated with an appropriate dilution of the inoculum to obtain an initial concentration of approximately  $3 \log_{10}$  cfu/ml. Tomatoes were incubated at 72°F (room temp.) and 41°C (refrigeration temp.) and growth was followed for 24 hrs of incubation. *Salmonella* colonies were enumerated on XLD agar after 24 hrs of incubation.

**Growth Parameters Calculations.** Bacterial concentrations were transformed into  $\log_{10}$  values. Lag phase duration times (LDT) and exponential growth rates (EGR) were calculated by fitting data to a linear function that allows for a lag period before initiation of exponential growth.

#### Results and Recommendations

## Results and Recommendations

Results are presented in Table 1. *S. Enteritidis* and *S. Newport* were able to grow on both Beefsteak and Roma tomatoes at 72°C. For cut tomatoes, lag duration times (LDT) ranged from 2.88 to 3.81 hrs for the Roma tomatoes and from 5.29 to 7.49 hrs for the Beefsteak. Beefsteak blended tomatoes showed an average LDT of 6.91 hrs compared to 3.4 hrs for the Roma. Exponential growth rates (EGR) ranged from 0.185 to 0.266 logs/ hr and from 0.166 to 0.297 logs/hr, for Roma and Beefsteak tomatoes, respectively. The low pH with a high water activity (>0.99) of the tomatoes was not found to inhibit *Salmonella* spp. growth in cut tomatoes (See Table B, "[Interaction of pH and  \$a\_w\$  for control of vegetative cells and spores in food not heat treated or heat treated but not packaged](#)" in the definition of Potentially Hazardous Food (Time-Temperature Control for Safety Food), Section 1-201.10(B) in the 2005 Food Code). No growth was observed on the tomatoes incubated at refrigeration temperatures (41°C).

**Table 1: Growth Kinetics of *Salmonella* Enteritidis and *Salmonella* Newport in Beefsteak and Roma Tomatoes at 72°F and 41°F.**

Inoculation method/ Incubation temp <sup>a</sup>	Beefsteak					Roma				
	Rep	pH	$a_w$	LDT <sup>b</sup> (h)	EGR <sup>c</sup> (log/h)	Rep	pH	$a_w$	LDT (h)	EGR (log/h)
Cut tomatoes held at 72°F	1	4.27	0.996	5.29	0.2210	1	4.56	0.995	3.34	0.222
	2	4.88	0.995	6.99	0.2972	2	5.12	0.994	2.88	0.256
	3	5.04	0.993	7.49	0.2941	3 <sup>c</sup>	4.23	0.999	3.81	0.2657
	4 <sup>c</sup>	4.29	0.995	5.48	0.2438					
	5 <sup>d</sup>	4.23	0.995	5.41	0.2939					
Cut tomatoes held at 41°F	1	5.04	0.993	indefinite	no growth	1	4.23	0.999	Indefinite	no growth
	2 <sup>d</sup>	4.29	0.995	indefinite	no growth					
	3 <sup>e</sup>	4.23	0.995	indefinite	no growth					
Blended tomatoes held at 72°F	1	4.88	0.995	6.91	0.1658	1	5.12	0.994	3.40	0.1854

Source: Antonio De Jesús, CFSAN Microbiologist

<sup>a</sup> All tomato temperatures were 41°F at the time of inoculation.

<sup>b</sup> LDT means Lag Phase Duration Time

<sup>c</sup> EGR means Exponential Growth Rate

<sup>d</sup> *Salmonella* Newport from a mango outbreak was used for this repetition using tomatoes from a local grocery store.

<sup>e</sup> *Salmonella* Newport from a tomato outbreak was used for this repetition using tomatoes from a restaurant supplier.

## ATTACHMENT C Recommendations for Food Establishments Serving or Selling Fresh Tomatoes Purchasing

1. Consider making purchase specifications to the supplier that tomatoes are grown using Good Agricultural Practices (GAPs). FDA's "[Guide to Minimize Microbial Food Safety Hazards for Fresh Fruit and Vegetables](#)" provides useful information about GAPs and safely growing, harvesting, sorting, packing and distribution of produce.
2. Ripe tomatoes should be delivered to a food establishment in a refrigerated truck for both quality and safety.
3. Consider that purchase records may be needed for a traceback if a foodborne illness outbreak occurs.

### Storage

4. After receiving fresh tomatoes, review and follow storage directions regarding temperature, "use by" dates, etc. Avoid using damaged and partially decayed tomatoes. Refrigerate cut tomatoes at 41°F or less.
5. Store whole fresh tomatoes, a raw agricultural commodity, in such a way that they do not contaminate other processed foods including ready-to-eat fresh produce with soil, etc. Store any fresh tomatoes, whole or cut, where other products especially raw meat and poultry cannot cross-contaminate them.
6. Segregate fresh produce from other refrigerated foods in refrigeration units by using a separate set of storage racks or separate cooler, if possible. Protect (by covering) and store washed, cut tomatoes above unwashed, uncut fresh produce. Store all produce off the floor.

### Washing and Preparation.

7. Stop work immediately and report to the person in charge any symptoms of vomiting, diarrhea, jaundice (yellow eyes and skin), sore throat with fever or an exposed, infected lesion (cut, burn, boil, etc.) on hands or arms.
8. Wash hands thoroughly with soap and running water before and after handling fresh

tomatoes and other produce.

9. All sinks, utensils, cutting boards, slicers, etc. should be washed, rinsed and sanitized before use with fresh tomatoes and other fresh produce.
10. Always wash whole tomatoes and other intact fresh produce under running, potable water before use. Soaking produce or storing it in standing water is not recommended for tomatoes or for most other types of fresh produce.
  1. Washing fruits and vegetables with soap or detergent is not recommended.
  2. Scrubbing with a clean brush is only recommended for produce with a tough rind or peel such a cantaloupe or citrus that will not be bruised or penetrated by the brush bristles.
  3. Maintain the wash water temperature at 10°F warmer than the temperature of any produce being washed.
  4. "Fresh-cut" tomatoes and other produce have already been washed before processing and should be considered ready-to-eat with no further need for washing unless the label says otherwise.
11. After being washed and cut, tomatoes are considered potentially hazardous food requiring time/temperature control for safety (TCS) and should be refrigerated at 41°F or less to prevent any pathogens that may be present from multiplying.
  - a. Any cut tomatoes that may be held refrigerated longer than 24 hours should be date marked.
  - b. Cut tomatoes may be held at ambient temperature for short periods of time (Time as a Public Health Control, Section 3-501.19 of the 2005 Food Code) if certain conditions are met:
    1. Cut tomatoes may be held un-refrigerated for up to 4 hours if the tomatoes are 41°F or less when removed from temperature control, a marking system is used to identify when the 4 hours is up and, if not consumed or cooked, the cut tomatoes should be discarded.
    2. Cut tomatoes may be held un-refrigerated for up to 6 hours if the tomatoes are 41°F or less when removed from temperature control, the temperature of the tomatoes is monitored and never rises above 70°F, a marking system is used to identify when the 6 hours is up and, if not consumed or cooked, the cut tomatoes are then discarded.
12. Foods which contain cut tomatoes are considered potentially hazardous food requiring time-temperature control for safety (TCS) or refrigeration at 41°F or less, unless:
  1. Criteria for Time as a Public Health Control are met (see #11(b) above),
  2. Cut tomatoes or food containing cut tomatoes as an ingredient is acidified and reaches a pH below 4.2. The pH should be verified. Examples include:
    1. Salsa with cut tomatoes acidified with vinegar, lemon juice or lime juice.
    2. Marinated cut tomatoes with vinegar, acidified salad dressing, etc.

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