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Cooling Rates of Chili Using Refrigerator, Blast Chiller, and Chill Stick Cooling Methods

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ABSTRACT

Purpose/Objectives

The purpose of this study was to compare the time and temperature differences between six cooling methods of chili using three types of cooling equipment available in foodservice operations. The objective was to determine which cooling method best met the amended 2001 Food and Drug Administration (FDA) Food Code cooling standards.

This study addresses a number of factors involved in cooling-related foodborne illness outbreaks and generates results that could be used to 1) develop educational recommendations for improving the practices of food handlers; 2) help update and/or verify effective cooling methods for foodservice operations; and 3) provide data for continuing research on foodservice cooling methods.

Methods

Chili was cooled using six methods: 1) 12x10x2½" pan in a walk-in refrigerator; 2) 12x10x4" pan in a walk-in refrigerator; 3) three-gallon stainless steel stockpot in a walk-in refrigerator; 4) 12x10x2½" pan in a blast chiller; 5) 12x10x4" pan in a blast chiller; and 6) three-gallon stainless steel stockpot using a chill stick in a walk-in refrigerator. Each method was replicated three times and the mean time and temperature were calculated to determine its cooling rate.

Results

Of the three types of cooling equipment used (blast chiller, walk-in refrigerator, and chill stick), only the blast chiller met the amended FDA guidelines concerning cooling cooked food. The FDA 2001 Food Code, which was amended in 2003 to reduce the upper endpoint temperature from 140˚F to 135˚F, suggest reducing food temperature from 135˚F to 70˚F in two hours, and then from 70˚F to 41˚F in four hours. The study also found that the use of a chill stick in the three-gallon stock pot significantly reduced the cooling times of cooked chili.

Applications to Child Nutrition Professionals

The results of this study provide data for child nutrition professionals to make informed choices concerning food cooling procedures and emphasize the need for school foodservice operations to evaluate the effectiveness of current cooling methods.

INTRODUCTION

Food safety is a concern for school foodservice directors. Between 1973 and 1999, a total of 15,831 foodborne outbreaks were reported, resulting in 447,483 cases of foodborne illness, 20,119 hospitalizations, and 457 fatalities (U.S. General Accounting Office, 2003). Although the proper cooling of cooked food has been shown to significantly reduce the chance of foodborne illness, cooling is often done incorrectly. In many school foodservice operations, not only is cooling equipment unavailable, but the time and temperature of food are seldom checked during the cooling process (Henroid & Sneed, 2004). Improper cooling of cooked food has been identified as the top factor contributing to the occurrence of outbreaks (Bryan, 1988).

Using surveillance data collected between 1993 and 1997, Olsen et al. (2000) examined five contributing factors of foodborne illness (improper holding temperatures, inadequate cooking, contaminated equipment, food from unsafe sources, and poor personal hygiene) and found that, by far, improper holding temperature was the largest outbreak trigger. Henroid and Sneed (2004) conducted a study that evaluated schools' readiness to implement a Hazard Analysis Critical Control Point (HACCP) system. This study observed the food cooling rate of various institutions and found that only six out of ten school foodservice operations examined for proper cooling methods were in compliance with the FDA Potentially Hazardous Food (PHF) cooling standards (FDA/CFSAN, 2001). Of these non-compliant foodservice operations, the study detected several cooling practices that were potential food safety hazards.

Foodborne illness as a result of improper cooling methods are caused by microorganisms, such as Clostridium perfringens, which can survive cooking and thrive in environments of prolonged cooling (Heredia & Labbé, 2001). During cooking, protective heat-resistant spores allow C. perfringens to survive high temperatures that kill most organisms. It is during prolonged cooling that C. perfringens multiply rapidly, which lead to the high microbial levels encountered in food poisoning. After ingesting high amounts of C. perfringens in improperly cooled food, humans may experience abdominal cramps, bloody diarrhea and, in rare cases, even die from C. perfringens enterotoxin poisoning (Heredia & Labbé, 2001).

The purpose of this study was to develop time and temperature cooling curves for six treatments of chili cooled using three different types of cooling equipment: a walk-in refrigerator; a blast chiller; and a chill stick. This study addressed factors involved in cooling-related FBI outbreaks, and generated results that could be used to: (a) develop educational recommendations for improving practices of food handlers; (b) help update and/or verify effective cooling methods for foodservice operations; and (c) provide data for continuing research on foodservice cooling methods.

MATERIALS AND METHODS

Sample and Sample Preparation

Chili con carne with beans was prepared using a recipe from USDA Recipes for Child Nutrition Programs obtained from the National Food Service Management Institute (NFSMI, 1999). USDA commodity ground beef was secured for the study.

Cooking Procedures

The chili was prepared in a university quantity food production (QFP) laboratory, using a 15-gallon Cleveland tilting skillet. All recipe ingredients and cooking procedures were conducted under carefully controlled laboratory conditions, which were replicated for each trial. The same individual prepared the chili in the dedicated QFP laboratory, using identical ingredients and equipment for each replication. There were no other concurrent food production activities taking place during the study's replication period.

Cooling Procedures
After cooking, the chili was transferred while still hot (190˚F/87˚C) into three differently sized containers for cooling. All containers were filled to capacity and used standard volumes for accuracy across replications. Three quarts of hot chili were placed into a 12”x10”x2½” stainless steel pan. Five quarts of hot chili were placed into a 12”x10”x4” stainless steel pan. Three gallons of hot chili were placed into a stainless steel stockpot. The same stainless steel containers were used for all three replications of the experiment.

A K-type probe was placed in the geometric center of the chili to measure the hottest area of the container during cooling. The K-type probe was attached to an Atkins model #37313 data recording thermometer programmed to read temperatures in ten minute intervals. Contrary to common foodservice activity, the chili was cooled uncovered, with the doors to the cooling equipment closed during the entire cooling process. Cooling food in this manner represents a controlled “best-case” scenario that can be used as a benchmark to assess other less controlled situations, such as those found during normal foodservice activity.

Cooling Methods
Hot chili was cooled to 41˚F using the six cooling methods and three different types of cooling equipment (walk-in refrigerator, blast chiller, and chill stick):

1. 12 x 10 x 2 ½” pan in a walk-in refrigerator
2. 12 x 10 x 4” pan in a walk-in refrigerator
3. Three-gallon stainless steel stockpot in a walk-in refrigerator
4. 12 x 10 x 2 ½” pan in a blast chiller
5. 12 x 10 x 4” pan in a blast chiller
6. Three-gallon stainless steel stockpot, using a chill stick in a walk-in refrigerator

Each of the six methods was replicated three times.

RESULTS AND DISCUSSION

As shown in Table 1, the chili cooling time varied greatly among the six cooling methods. Of the six methods, only the two-inch and four-inch blast-chilled pans of chili met the amended 2001 FDA Food Code (FDA/CFSAN, 2003) cooling guidelines for cooling potentially hazardous foods.

The three walk-in cooling methods showed the greatest deviation from the amended 2001 FDA Food Code guidelines, whereas the chill stick and blast chiller methods met or came within ten minutes of meeting the guidelines. The three gallon stockpot of chili took over 24 hours to cool in the walk-in refrigerator, but the addition of a chill stick reduced the cooling time by approximately 18 hours. The blast chiller was not used to cool the chili in the three-gallon stockpot due to space constraints.

Tables 2 and 3 show that although the chill stick took two hours and ten minutes to cool from 135˚F to 70˚F, which is a ten minute violation of the amended 2001 FDA Food Code, it passed the four hour standard by cooling from 70˚F to 41˚F in exactly four hours. Although the chill stick came within ten minutes of meeting FDA recommendations, it showed a significant reduction in cooling time, and might meet the recommendations if it were used in a smaller volume of chili.

CONCLUSIONS AND APPLICATIONS

This study showed that cooling methods most often used in schools are ineffective in meeting the amended 2001 FDA Food Code cooling standards. Blast cooling was the only method that met all FDA standards. Further, practices in this study represent a “best-case” scenario for the cooling of chili, and do not take into account variables inherent in actual foodservice establishments that could potentially increase the cooling duration, including opening and closing a refrigerator door and wrapping hot food tightly with aluminum foil or film before cooling.

- These results suggest several applications for school foodservice operations:
- The effectiveness of cooling methods used by foodservice operations should be determined and documented in each school. If the 2001 FDA Food Code standards are not met, changes must be made to meet them.
- Blast chillers are effective in cooling food at a rate that meets the 2001 FDA Food Code standards. While a blast chiller is a significant investment (roughly $10,000 for a small blast chiller), it should be considered when funds are available to upgrade equipment or when foodservice directors are remodeling or building new kitchens.
- Inexpensive, easy-to-use equipment such as chill sticks can be used to decrease the cooling times for liquid products such as chili, soups, etc. It is important to note that this approach increases labor time requirements, and school foodservice employees may not be available to oversee its use during the entire cooling period.
- Standard operating procedures (SOPs) for cooling various food products need to be developed for each school. SOPs should be used to train employees about appropriate documentation procedures and food cooling methods to ensure that cooling is done properly.

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BIOGRAPHY

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