Evaluating the Impact of School Foodservice Cooling Techniques on *Escherichia coli* Populations in Recipe Prepared Chili Con Carne with Beans

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Abstract

Introduction & Purpose: In preventing foodborne illness outbreaks, proper food preparation practices are especially critical in institutional settings where food products are prepared in large quantities. The third leading factor in outbreaks of school associated foodborne illness is improper or "slow" cooling. Therefore, conducting research regarding cooling methods that are both effective and feasible for preventing pathogen growth is critical to public health. The purpose of this study was to evaluate combinations of cooling techniques and their impact on *Escherichia coli* populations in a recipe prepared chili con carne with beans.

Methods: Chili was prepared according to a school nutrition program recipe and heated to 165°F, poured into steam table pans to 2 and 3 inch depths, then cooled to 135-140°F before inoculation with *E. coli* (target concentration of 10^4 CFU/g). Pans were stored in a commercial walk-in freezer (-20˚ C) or placed in ice water baths in a commercial walk-in refrigerator (4˚ C). All pans were stored uncovered or covered with one or two layers of aluminum foil. Samples were plated onto MacConkey agar at 0, 4, 8, 12, and 24 hours, and incubated for 18-24 hours to enumerate *E. coli* populations.

Results & Conclusions: No statistically significant difference (P>0.05) in *E. coli* population was observed for cover (two layers, one layer, uncovered), treatment (refrigerator vs. freezer), or depth variables. However, time (P=.0015) and a two way interaction, depth by time (P=.0197), were significant for this product. Although time was statistically significant, the largest recorded change in *E. coli* population (-0.1755 log10 CFU/g) between time points 4 and 12 may not be considered microbiologically significant. Depth by time was also statistically significant, with the largest population change (-0.2777 log10 CFU/g) recorded for three inch food depths between time point 0 and time point 4. For two inch depths, the largest change in *E. coli* population (-0.1534 log10 CFU/g) occurred between time point 0 and 12. This data indicates that most cooling treatments evaluated were effective at controlling *E. coli* populations in commercially prepared chili product.

Introduction

Schools are associated with the largest number of outbreaks (286) and illnesses (17,266) when compared with other institutions like daycares, workplace cafeterias, and prisons or jails (1). The National School Lunch Program serves over 31 million children each day, contributing to the significant size of outbreaks and number of illnesses (2). Improper or "slow" cooling is a considerable risk for schools and other institutional settings and has been identified as the third leading factor in school associated foodborne illness (3). When food is prepared in large quantities, the risk to public health lies in the cooling process when food is stored until later service. Therefore, the Food and Drug Administration issued a food code in 2009 that requires food products to be cooled to 70°F within two hours of cooking and down to 41°F within a total of six hours. Several studies have evaluated cooling techniques for food products commonly used in school nutrition programs (4,5) and have concluded that very few techniques meet the 2009 FDA food code standards. This study was conducted to evaluate surrogate *E. coli* survival during 24 hours of cooling as a follow up to these studies.

Figure 1: Pan preparation and cooking equipment. Upper left: Steam table pans with data loggers and appropriate treatment. Bottom left: Device used to keep temperature probe in the center of the pan. Right: Commercial grade tilt skillet used to prepare the chili con carne with beans.

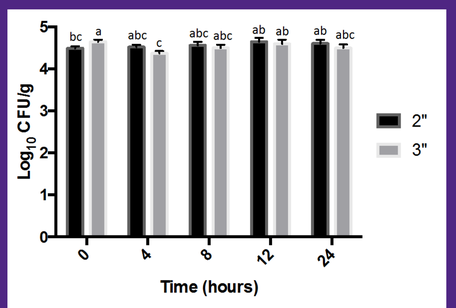

Figure 2: Data were analyzed by depth and time because of the two way interaction significance. Error bars represent standard error of the mean.

Data are shown according to significance detected. However, because the largest difference was .2777 log10 CFU/g, differences in depth by time values are not indicated with superscripts.

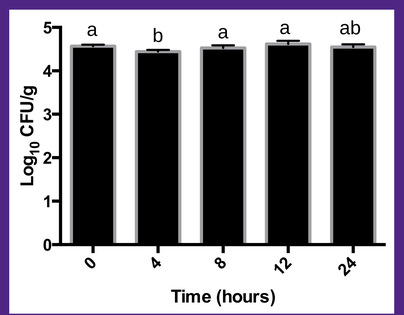

Figure 3: Data were analyzed by time alone because time was a single significant factor. Error bars represent standard error of the mean.

[ab] Different superscripts indicate statistically significant difference (P<0.05)

Selected References

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Methods

***Experimental Design*:** This study was developed to test the efficacy of cooling techniques used by school nutrition programs on controlling microbial growth, such as *Escherichia coli* (*E. coli*). In this study, four ATCC strains of *E. coli* were combined in a cocktail to a target population of 10^4 CFU/g in order to accurately simulate survivability of the foodborne pathogen *E. coli* O157:H7 in chili con carne with beans.

***Sample Preparation*:** Chili was prepared according to a school nutrition program recipe, heated in a commercial tilt skillet to 165°F , and then prepared at two and three inch depths in steam table pans. The product was allowed to cool to 140°F and then inoculated with the *E. coli* surrogate cocktail.

***Treatments*:** Six different treatments were evaluated to determine if there was an effect on the rate of cooling and subsequent microbial growth. Two and three inch steam table pans were portioned and either left uncovered and exposed to air, covered with one layer of aluminum foil that allowed a gap for air exposure, or covered with two layers of aluminum foil without a gap for air exposure between the foil and food product. These treatments were duplicated in a walk-in freezer and walk-in refrigerator. Pans in the walk-in refrigerator were situated in ice baths to model common food cooling techniques.

***Microbiological Analysis*:** A composite sample of chili was collected from various locations in each pan at sampling time points of 0, 4, 8, 12, and 24 hours. Composite samples were mixed by hand, measured to 25 gram samples and stomached for one minute with 225 mL of buffered peptone water (BPW). Samples were then serially diluted in BPW and dilutions were spread-plated onto MacConkey agar (MAC). MAC plates were incubated for 18-24hrs and lactose fermenting colonies were enumerated and recorded.

Data Analysis: Data were analyzed as using a mixed procedure, repeated measures model in SAS.

Conclusion and Significance

Time was statistically significant for this food product (P=.0015). The slight decrease in *E. coli* population over time indicates an effective control for the cooling methods evaluated. The time by depth interaction was significant for this food product as well (P=.0197). The decrease in *E. coli* population over time for the two and three inch food depths also demonstrates an effective control for the cooling methods evaluated. Although these effects were statistically significant, it should be noted that the variation observed in population was well under 0.5 Log_{10} CFU/g. It is possible that this small degree of difference is the result of natural variation in populations throughout the food. These results, along with the lack of statistical differences among cover and treatment variables, indicate that a majority of foodservice cooling methods evaluated were effective at controlling *E. coli* populations in chili con carne with beans.

Acknowledgements

This project has been funded, at least in part, with Federal funds from the U.S. Department of Agriculture. The contents of this publication do not necessarily reflect the views or policies of the U.S. Department of Agriculture nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.