Evaluating the Impact of Cooling Techniques on Bacillus cereus Populations in Brown Rice

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Abstract

Introduction: In institutional settings, large quantities of food may be cooked, cooled, and stored for later service. Improper, or "slow," cooling has been identified by the United States Food and Drug Administration as a contributing factor in foodborne illness outbreaks. Therefore, validating cooling methods that are feasible and effective at preventing pathogen growth is critical for public health.

Purpose: This study was designed to test the efficacy of cooling technique combinations on controlling Bacillus cereus spore outgrowth within brown rice.

Methods: Brown rice was prepared according to product label instructions and then cooled to 135-140°F before inoculation with spores (10^5 spores/g) of B. cereus. All pans were stored in a commercial walk-in freezer (-20°C) or placed in ice water baths stored inside a commercial walk-in refrigerator (-4°C), either uncovered or covered with one or two layers of aluminum foil. Samples were obtained at 0, 4, 8, 12, and 24 hours, plated on Mannitol Egg Yolk with Polymyxin B agar, and incubated for 24-48 hours to enumerate B. cereus populations.

Results: Treatment/time (P=0.0026) and product depth/time (P=0.0268) were statistically significant for B. cereus populations within the brown rice product during cooling. B. cereus populations decreased by 0.37 log10 CFU/g between 0 and 24 hours when stored in the freezer, whereas populations decreased by 0.09 log10 CFU/g between 0 and 24 hours when stored in the refrigerator. B. cereus populations decreased in both 2 and 3-inch depth treatments between 0 and 24 hours by 0.21 log10 CFU/g and 0.25 log10 CFU/g, respectively.

Significance: The slight decrease in B. cereus populations observed over the 24-hour cooling period, combined with no significant difference (P=0.05) in B. cereus population observed for the cover (two layers, one layer, uncovered) variable, indicate that all cooling techniques were effective at controlling B. cereus population outgrowth from spores in prepared rice.

Methods

Experimental Design: This study was designed to test the efficacy of cooling techniques which could be used by school nutrition programs on controlling microbial growth. Two strains of B. cereus (ATCC 11778 and 14579) were combined in a cocktail, heat-shocked (80°C for 10 min) and inoculated into rice to provide a target population of 10^5 spores/g.

Sample Preparation: Water was added to uncooked brown rice according to product label instructions and cooked in 2- and 3-inch steam table pans using commercial-grade convection ovens. The product was allowed to cool to 135-140°F and then inoculated into the refrigerator, with the walk-in-refrigerator (-4°C) and walk-in refrigerator (-20°C) storage scenarios. Pans in the walk-in refrigerator were situated in ice baths to model common food cooling techniques.

Microbiological Analysis: A composite sample of brown rice was collected from various locations in each pan at 0, 4, 8, 12, and 24 hours of chiling. Sample trays 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 serial diluted in BPW and dilutions were spread-plated onto Mannitol Egg Yolk with Polymyxin B agar. Plates were incubated for 18-24 hrs and flat, pink colonies with an opaque zone were counted and recorded.

Data Analysis: Data were analyzed using the mixed procedure with repeated measures modeling in SAS.

Conclusion and Significance

A storage location*time interaction was observed. Between 0 and 24 hours of cooling, brown rice stored in the freezer demonstrated a B. cereus population decrease of 0.37 log10 CFU/g. Between time points 0 through 24 hours, the ice bath stored in the refrigerator was responsible for a B. cereus population decrease of 0.09 log10 CFU/g. A product depth*time interaction was also observed. Bacillus cereus populations did decrease overall in both 2- and 3-inch product depths between time points 0 and 24 hours (0.21 log10 CFU/g and 0.25 log10 CFU/g, respectively). The small but statistically significant decreases in B. cereus populations from the two significant variable interactions demonstrate that all twelve cooling techniques investigated were effective at controlling B. cereus populations.

Young children are at an-risk population for severe illness and life-threatening complications from foodborne pathogens. Therefore, it is necessary to conduct research to discover and evaluate cooling methods that are effective at controlling foodborne pathogens in school lunch programs and to translate these data into practical materials for training foodservice personnel, school nutrition program personnel and other commercial food service personnel.

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