The sanitization efficacy of a mechanical warewashing process with reduced wash and rinse temperatures

Final Report

Melvin Pascall, Jaesung Lee

Department of Food Science and Technology

The Ohio State University

Introduction:

Current FDA Food Code guidelines and NSF International Standard 3 requirements include minimum wash and final rinse temperatures for mechanical warewashing processes in the foodservice industry. These guidelines have been carried over since the early 1950's when studies were carried out to show the amount of heat, water volume, pump pressure and exposure time necessary for adequate sanitizing. These physical design constraints were included in the National Sanitation Foundation Standard 3 for Commercial Dishwashers. The Food Code also relied upon design criteria to assure adequate sanitization. In 1977, NSF 3 was updated to remove some of the design constraints and rely more on the performance criteria of 3600 Heat Unit Equivalents (HUE), based on the USDA milk pasteurization curve. This study showed that a further reduction in the design restriction but retaining the performance criteria will in fact maintain the same level of public health safety while substantially reducing energy consumption.

In the choice of a procedure to determine if washing and rinsing protocols meet the requirements of the Food Code, the choice of the test utensil, contaminating food type, challenge bacteria, reagent type and concentration/temperatures and exposure time should be carefully chosen so that a worst case scenario is created. Thus, less difficult to clean utensils, which include typical real world applications, would be properly sanitized by the chosen protocol. A milk-based product, soft cream cheese, was selected because an initial study performed by authors Lee and Pascall (2007), showed that milk products left on dirty dishes were found to harbor the highest bacterial load when compared with other types of food soils.

Objective:

The main goal of this study was to determine if reduced wash and rinse temperatures in a mechanical dishwashing process will have a negative impact on sanitizaton compared to existing minimum wash and rinse temperatures.

To meet the stated goal above, the objectives of this project were:

1. To evaluate the hot-water sanitization efficacies of a mechanical dishwashing processes on **ceramic plates cleaned at two different washing and rinsing temperatures (**160°F washing followed by 180°F rinsing, and 155°F washing followed by 170°F rinsing**).**
2. To demonstrate that reduced wash and rinse temperatures can maintain the sanitizing performance criteria of 5-log reduction in bacterial load, or 3600 heat unit equivalents**.**

Methods:

Bacterial Sample

Escherichia coli K12 (ATCC 29181) and *Listeria innocua* Seeliger (ATCC 33090) were used as surrogate organisms during this study. The cultures were stored frozen (-176°F) in 30% (v/v) sterile glycerol. When required for testing, a loopful of each organism was revived in 10 ml Trypticase soy broth supplemented with 0.3% (w/w) yeast extract (TSBYE) and incubated at 98.5°F for 24 h. A loopful of broth from this was inoculated on a Tryptic soy agar with a 0.3% (w/w) yeast extract (TSAYE) slant and incubated for 18 h at 98.5°F. The cells grown on the slant were stored at 37.5°F and used as a stock culture. At each experiment, a loopful of this stock culture was transferred to 20 ml TSBYE and incubated at 98.5°F until the final concentration of cells in the medium reached about 1.0 x 10^9 cfu ml^{-1}. Cells in the broth were harvested by centrifugation at 10,000 g for 10 min at 39°F. The supernatant was discarded and the pellets were resuspended in 20 ml sterile deionized potassium phosphate buffer (pH 7.2). Each cell suspension was separately mixed with each of the food samples to be tested in this study.

Preparation of the Food Samples

The contaminating organic matter (food items) used in this study was processed semi-solid cream cheese (15% fat). All food items were purchased from a local store the day before each experiment and kept at 39°F. There was no evidence of microbial growth on the TSAYE plated 10^{-1} diluted (w/w) food items. Cell suspensions of *E. coli* or *L. innocua* were inoculated into the cream cheese (1:10 w/w) and mixed to give an initial cell count of at least 1.0 x 10^8 cfu per food item. The cream cheese was pasted on to 8.5 inch ceramic plates (5 g for each plate). Contaminated plates were air-dried for 1 h at 75°F then exposed to varying washing cycles using a CL44e mechanical dishwasher manufactured by Hobart Corporation (Troy, OH). In order to determine the effect of air drying on the bacterial survival and to estimate the initial number of inoculated organisms on the food contaminated plates to be washed, each food type pasted on to a

set of the plates was sampled after air drying. After serial dilutions, bacteria survival numbers were determined by the plate count method.

Dishwashing Process on Test Plates

The inoculated plates were washed in the mechanical dishwasher. In each experiment, three different racks containing three plates were tested. The plates were placed in different positions in the rack. During the experiment, the plates in the racks were washed with 1,000 ppm of a Guardian Score (Ecolab, Inc., St. Paul, MN) detergent at 160ºF and rinsed at 180ºF. Prior to using the mechanical dishwasher, it was cleaned with hot water and filled with fresh detergent and water. The wash water was sprayed onto the plates at a flow rate of approximately 165 gallons per minute. Subsequently, the plates were rinsed with fresh water at a pressure of 20 psi. After washing and rinsing, all plates were placed on a sterile rack and air-dried for 15 min at 75°F prior to sampling. At the reduced temperature experiment, the test was performed at a wash temperature of 155ºF and rinsed at 170ºF.

Microbiological Sampling of the Utensil Surfaces

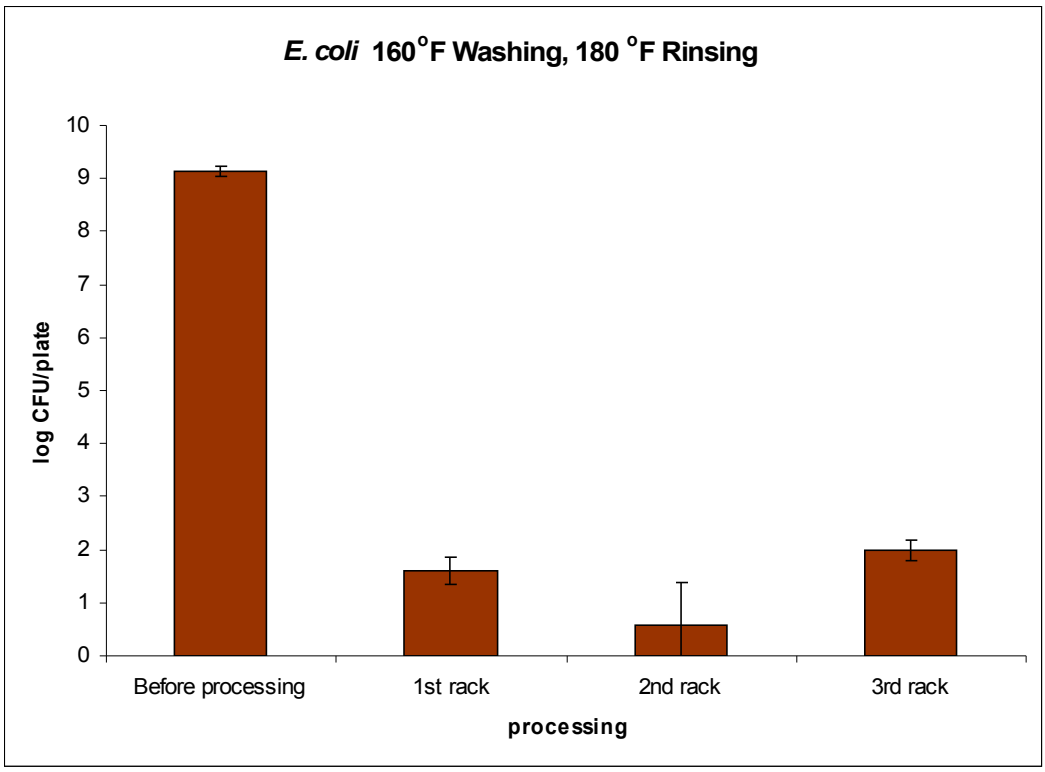
In the sampling for microbial enumeration, hygiene swabs were used to collect organisms from the surface of the plates that were previously washed. The swabs, made with sterile calcium alginate fiber tips on a wood applicators (Fisher Scientific, Pittsburgh, PA), were moistened before use with sterile peptone water. These swabs were transferred to test-tubes containing 2 ml of the peptone water. These tubes were then vigorously vortexed to release any bacterial cells from the fiber tip of the applicators.

Microbiological and Statistical Analysis

All cells were serially diluted and plated onto TSAYE to determine their viable counts after 24 h incubation at 98.5ºF. The detection limit for the test organisms was 2 CFU per the plate. In order to determine if the bacterial count on the washed samples resulted from organisms that were inoculated into the food, we simultaneously tested a comparable sample of food that was not inoculated with the bacterial species. The presence of any colonies in the comparable sample after washing would be evidence of contamination and in such cases, the entire batch of samples would be discarded. No less than two trials were used in each experiment. Variances of

microbial viability were analyzed by equal-variance *t*-test using a Microsoft Excel data analysis program (Ontario, Canada). The level of significance was set for $P<0.05$.

Figure 1. Enumeration of *E. coli* on plate before and after processing at different temperature using the mechanical dishwasher.



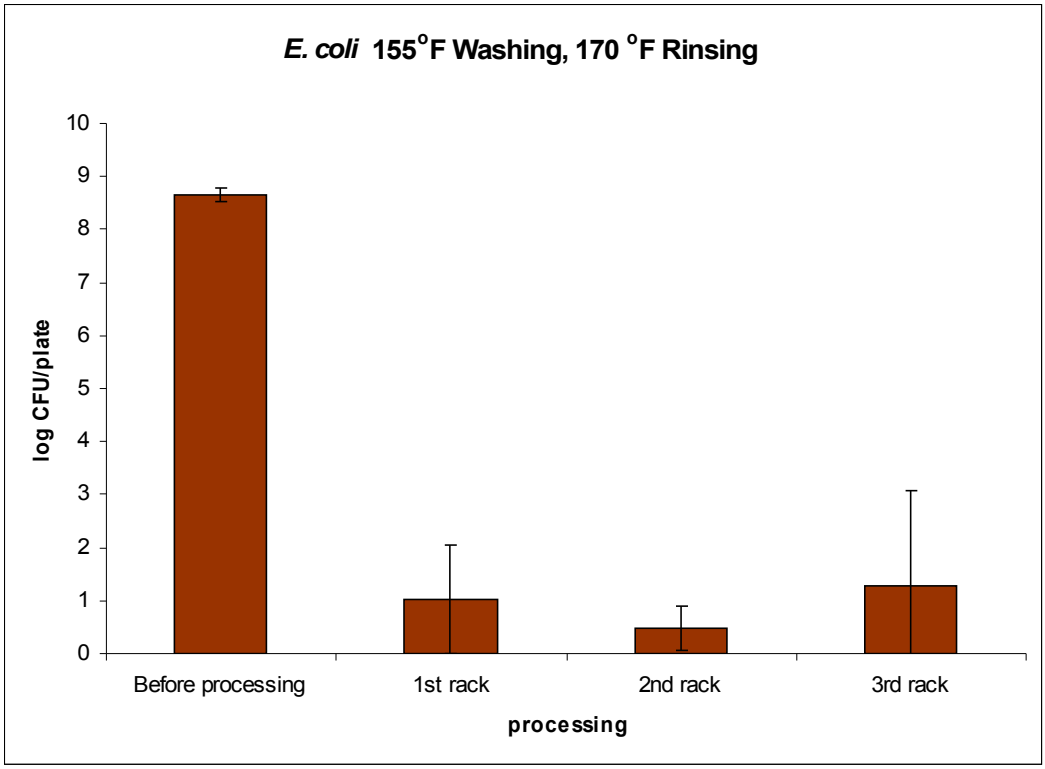
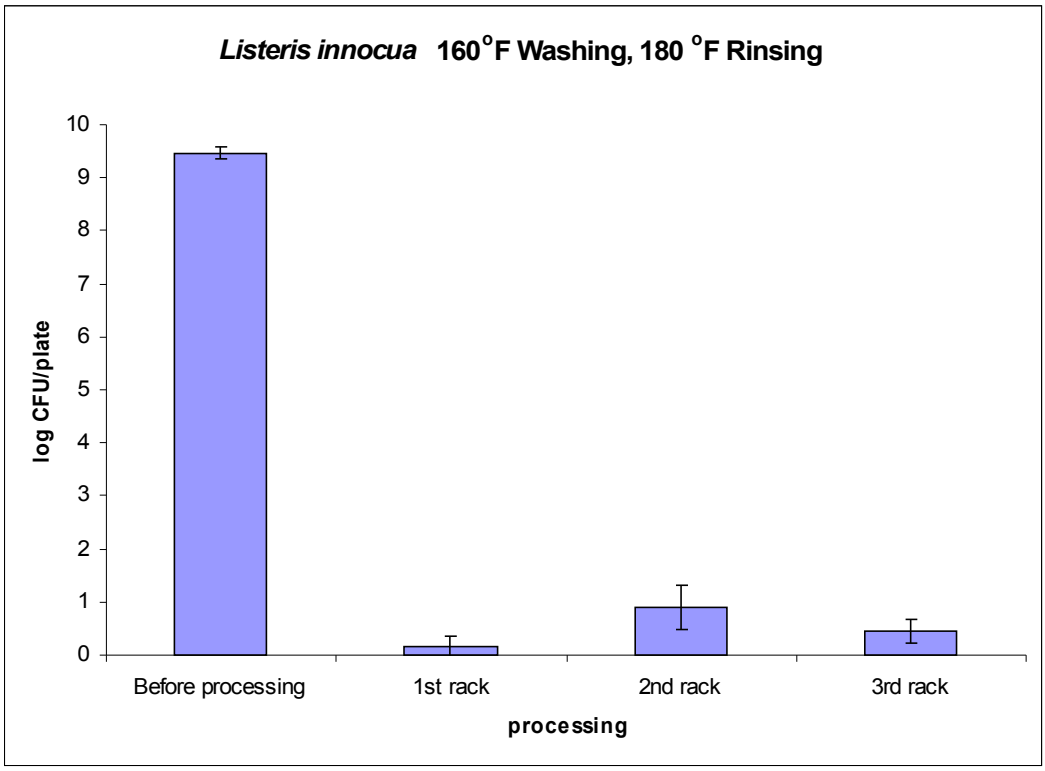
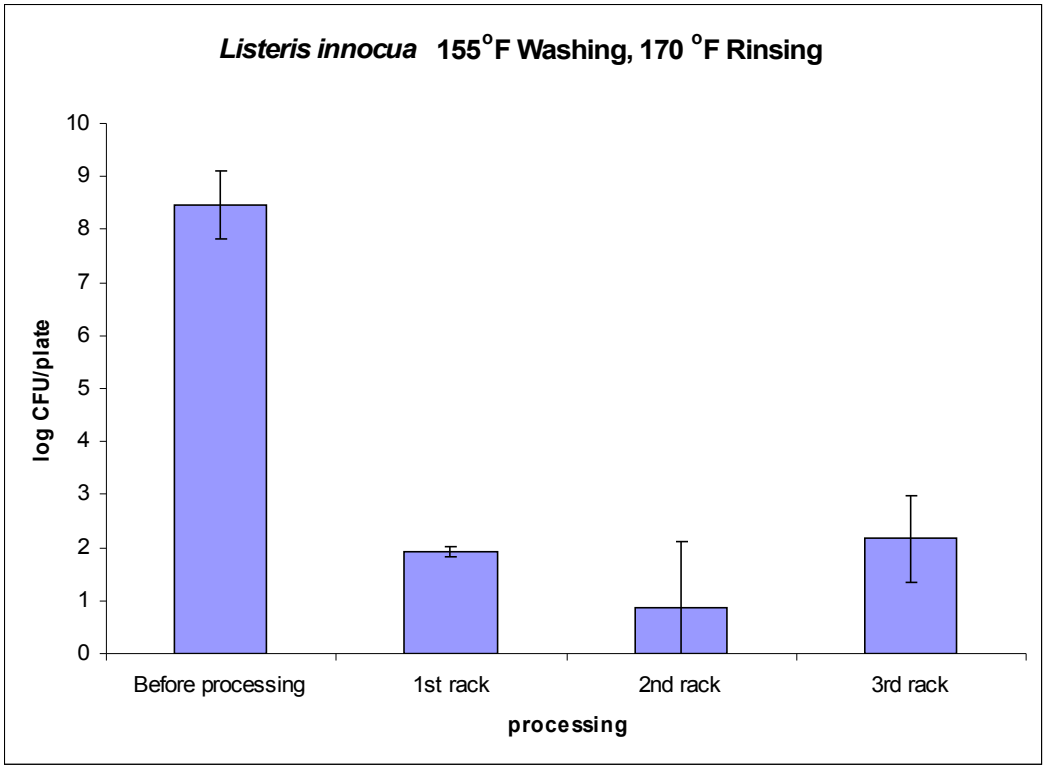


Figure 2. Enumeration of *L .innocua* on plate before and after processing at different temperature using the mechanical dishwasher.





Findings

- The application of lower washing and rinsing temperatures did not significantly (P>0.05) reduce the efficacy of the mechanical dishwashing process for bacterial numbers on the test plates compared with that on plates processed at standard temperatures (160ºF wash and 180ºF rinse).

- The results in Figures 1 and 2 show that all dishwashing processes had the ability to produce the 5-log bacterial load reduction.