Objectives

To determine the temperature-death times of Salmonella and L. monocytogenes in beef patties, chicken patties, chicken tenders, and frankfurter batter at four different temperatures and validate these findings using commercial products and cooking processes.

Materials and Methods

D-value determination. Two hundred grams of finely ground meat were inoculated to 8-log cfu/g of either Salmonella or L. monocytogenes (5-strain mixtures). One-g samples of inoculated meat were flattened into a thin film in moisture-impermeable pouches and vacuum-packaged. Samples were heated at one of four temperatures (54.4, 60.0, 65.6, and 71.1°C) in a water bath. Triplicate samples were removed periodically during cooking, chilled to ≤ 4°C, and enumerated for the survival of Salmonella or L. monocytogenes. D-values were calculated from the linear regression on log reduction of pathogen versus time. This experiment was replicated three times.

Batch oven validation. Inoculated frankfurter links were thermally processed in a combination steam/convection oven following one of 2 cook schedules until an internal temperature of 71.1°C was achieved. The control cycle met USDA, FSIS Appendix A relative humidity requirements while the test cycle only applied steam during the final step of the process. For both cycles, triplicate links were removed when product internal temperature reached 54.4°C, 62.7°C, and 71.1°C. This experiment was replicated twice.

Impingement oven validation. Inoculated beef patties, chicken patties and, chicken tenders were cooked via passage through two in-line impingement ovens. Samples were cooked to one of two temperatures (71.1°C and 79.4°C for poultry, 71.1°C and 76.7°C for beef) following either a control cycle or a test cycle. The control cycle applied no steam while the test cycle used a target wet-bulb temperature of 71.1°C (for target 1.2% rH) in the second oven. For each trial, triplicate samples were removed prior to cooking and on exit from each oven for enumeration of surviving pathogens. This experiment was replicated twice.

Results

D-values for Salmonella were shorter than those for L. monocytogenes across all products and temperatures tested. For batch oven cooking, both cook cycles resulted in ≥ 5.0 log reduction of Salmonella and L. monocytogenes in frankfurters. With a target temperature of 71.1°C, the control and tests cycles produced a 4.21 ± 2.22 and 5.53 ± 0.06 log reduction of L. monocytogenes in chicken tenders, respectively, during impingement cooking. Neither cycle was able to produce ≥ 5.0 log reduction of Salmonella in chicken tenders cooked to 71.1°C.

Conclusion

For non-impingement processes USDA, FSIS Appendix A time-temperature recommendations are adequate for controlling 1) Salmonella when the final cooking temperature meets or exceeds 60.0°C and 2) L. monocytogenes when the final cooking temperature meets or exceeds 71.1°C. Salmonella is more thermotolerant than L. monocytogenes during impingement processing. D-values suggested that 71.1°C should produce an instantaneous ≥ 5.0 log reduction of Salmonella however this was not observed in rapid processes (≤4.0 min) Incorporation of high wet-bulb temperature targets into impingement processes may be necessary to ensure adequate control of Salmonella.