

2002 MAFMA Final Report

Project Title **Control of *Clostridium perfringens* and *Clostridium botulinum* in Cooked, Ready-to-Eat Beef Products by Chemical Antimicrobials during Extended Chilling Process**

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Abstract

Inhibition of the germination and outgrowth of *Clostridium perfringens* by buffered sodium citrate (Ional) and buffered sodium citrate supplemented with sodium diacetate (Ional Plus) during the abusive chilling of roast beef and injected pork was evaluated. Beef top rounds or pork loins were injected with a brine containing NaCl, potato starch, and potassium tetrapyrophosphate to yield final in-product concentrations of 0.85, 0.25, and 0.20%, respectively. Products were ground and mixed with Ional or Ional Plus at 0, 0.5, 1.0, and 2.0%. Each product was mixed with a three-strain *C. perfringens* spore cocktail to obtain final spore concentrations of ca. 2.5 log₁₀ spores per g. Chilling of roast beef from 54.4 to 7.2°C resulted in *C. perfringens* population increases of 1.51 and 5.27 log₁₀ CFU/g for 18- and 21-h exponential chill rates, respectively, while chilling of injected pork resulted in increases of 3.70 and 4.41 log₁₀ CFU/g. The incorporation of Ional into the roast beef formulation resulted in *C. perfringens* population reductions of 0.98, 1.87, and 2.47 log₁₀ CFU/g with 0.5, 1.0, and 2.0% Ional, respectively, over 18 h of chilling, while 1.0% Ional Plus was required to achieve similar reductions (reductions of 0.91 and 2.07 log₁₀ CFU/g were obtained with 1.0 and 2.0% Ional Plus, respectively). An Ional or Ional Plus concentration of 1.0% was required to reduce *C. perfringens* populations in roast beef or injected pork chilled from 54.4 to 7.2°C in 21 h. Cooling times for roast beef or injected pork products after heat processing can be extended to 21 h through the incorporation of 1.0% Ional or Ional Plus into the formulation to reduce the potential risk of *C. perfringens* germination and outgrowth.

2. Results

The USDA-FSIS (33) stabilization requirements for processed meat and poultry products were established for the prevention of the germination and outgrowth of spore-forming bacteria that survive the normal heating regimes employed in the meat-processing industry. Furthermore, the USDA-FSIS has stated that *C. perfringens* can be used alone in an inoculated pack (challenge) study to demonstrate the the cooling performance standard is met for both *C. perfringens* and *Clostridium botulinum*, since the time-temperature conditions that would limit the growth of *C. perfringens* to ≤1 log₁₀ would also prevent the multiplication of *C. botulinum*, which is much slower. It is evident from the literature that organic acid esters such as sodium or potassium salts

of lactic, acetic, and citric acids inhibit the germination and/or outgrowth and botulinum toxin production of *C. perfringens* as well as *C. botulinum*.

The USDA-FSIS stabilization guidelines for the cooling of cooked meat products (6.5 h) can be extended by 14.5 h for roast beef and injected pork through the incorporation of either BSC (Ional) or BSC in combination with sodium diacetate (Ional Plus at >1.0%) into the formulation. Presently, a maximum BSC (Ional) level of 1.3% is approved for meat and poultry products for flavor retention and microbiological control (31). The incorporation of these antimicrobial agents into product formulations can be advantageous to meat processors in situations in which a product may not be cooled within the USDA-FSIS guidelines and can provide additional safety for meat products through the prevention of potential germination and outgrowth of *C. perfringens* when cooling process deviations occur. Caution should be exercised in extrapolating data obtained with model systems to other food systems, since *C. perfringens* germination and outgrowth may reach potentially hazardous levels when spores are present in raw meat ingredients.

3. Publications resulting from this research.

Thippareddi, H., V.K. Juneja, R.K. Phebus, J.L. Marsden, and C.L. Kastner. 2003. Control of *Clostridium perfringens* Germination and Outgrowth by Buffered Sodium Citrate during Chilling of Roast Beef and Injected Pork. *Journal of Food Protection* 66 (3), 376-381.