

Title: Use of Alternative Salts in Biltong Marinade to Reduce Sodium and Still Achieve USDA-FSIS >5-log Reduction of *Salmonella*

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Introduction: Biltong is a South African style dried beef product that is manufactured using lean beef marinated with salt, spice, and vinegar followed by a drying 5-10 day period at moderate heat and humidity. Despite the lack of a heat lethality step, the manufacturing process still must achieve a USDA-FSIS recommended 5-log reduction of *Salmonella* for safe production in the United States. Previous work in our lab achieved a 5-log reduction of *Salmonella* while simply using sodium chloride and vinegar in the marinade. The USDA-FSIS does not accept replacement of sodium chloride with alternative salts unless the recommended 5-log reduction of *Salmonella* can be proven.

Purpose: This study aimed to evaluate the use of the alternative salts, potassium chloride (KCl) and calcium chloride (CaCl₂) in biltong marinade to achieve the USDA-FSIS recommended 5-log reduction of *Salmonella*.

Methods: Beef pieces (1.9-cm x 5.1-cm x 7.6-cm) were inoculated with a five-serovar mixture of *Salmonella* (*Salmonella* Thompson 120, *Salmonella* Heidelberg F5038BG1, *Salmonella* Hadar MF60404, *Salmonella* Enteritidis H3527, and *Salmonella* Typhimurium H3380), vacuum-tumbled in a traditional biltong marinade comprised of spices (coriander, black pepper), 100-grain vinegar (4% formulation), and 2.2% salt (NaCl, KCl, or CaCl₂) and dried in a humidity-controlled oven for 8-10 days at 23.9°C (75°F) and 55% relative humidity. Microbial enumeration of *Salmonella* was conducted post-inoculation, post-marination, and after 2, 4, 6, 8, and 10 days of drying. Sodium, calcium, and potassium ion concentrations were measured using ion-specific meters. Trials were performed in duplicate replication with triplicate samples tested at each time period. Treatments were compared for significant differences ($p < 0.05$) by Repeated Measures One Way ANOVA.

Results: Biltong produced with CaCl₂, NaCl, or KCl achieved a > 5-log reduction of *Salmonella* after 6, 7, and 8 days respectively, with water activity < 0.85. Biltong processes made with NaCl or CaCl₂ were not significantly different ($p < 0.05$) but both were significantly different from biltong made with KCl ($p > 0.05$). Regardless of the salt used in the marinade, potassium ion levels were moderately elevated in all samples and was attributed to potassium found in beef.

Significance: KCl or CaCl₂ used in place of NaCl in biltong marinade was able to achieve > 5-log reduction of *Salmonella* to satisfy USDA-FSIS validation. The data provided herein with alternative salts will enable manufacturers to produce safe, healthy, and low-sodium RTE dried beef products for consumers.

Keywords: Biltong, dried beef, *Salmonella*, salt, process validation.