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

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What is biltong?

- South African style dried meat product
  - Similar to American style beef jerky
  - Uses lean strips of meat that is marinated in traditional spices, vinegar and salt
  - Dried at ambient humidity and temperature
- Biltong manufacturing does not meet USDA-FSIS beef jerky compliance guidelines, therefore producers have two options:
  1. Process demonstrate a >2-log reduction of *Salmonella* and perform testing of every lot of edible ingredient to ensure no *Salmonella*
  2. Process must demonstrate a >5-log reduction of *Salmonella*

Importance of Salt

- Salt (sodium chloride, NaCl) commonly used is large quantities in ready-to-eat (RTE) meat products such as biltong
  - Salt contributes to decreased water activity = limits microbial growth
  - Interferes with bacterial cellular mechanisms = limits microbial growth
- Increased consumption of high sodium content foods is associated with:
  - High blood pressure
  - Heart disease
  - Obesity
- Previous work has demonstrated >5-log reduction with NaCl in marinade

Goal: Evaluate the use of alternative salts (potassium chloride and calcium chloride) in the biltong marinade to achieve a 5-log reduction of *Salmonella*

Biltong Manufacturing/Sampling

- Beef pieces were inoculated with five-serovar *Salmonella* cocktail
- Vacuum-tumbled in a traditional biltong marinade of:
  - Spices (black pepper, coriander)
  - Vinegar (RWV; 100-grain)
  - Salt (either NaCl, KCl, $CaCl_2$)
- Beef was dried for 8-10 days at 23.9 °C/ 55% RH
  - Microbial enumeration of remaining *Salmonella* was conducted after marination and after 2, 4, 6, 8, and 10 days of drying

Bottom-Round Subprimal Beef

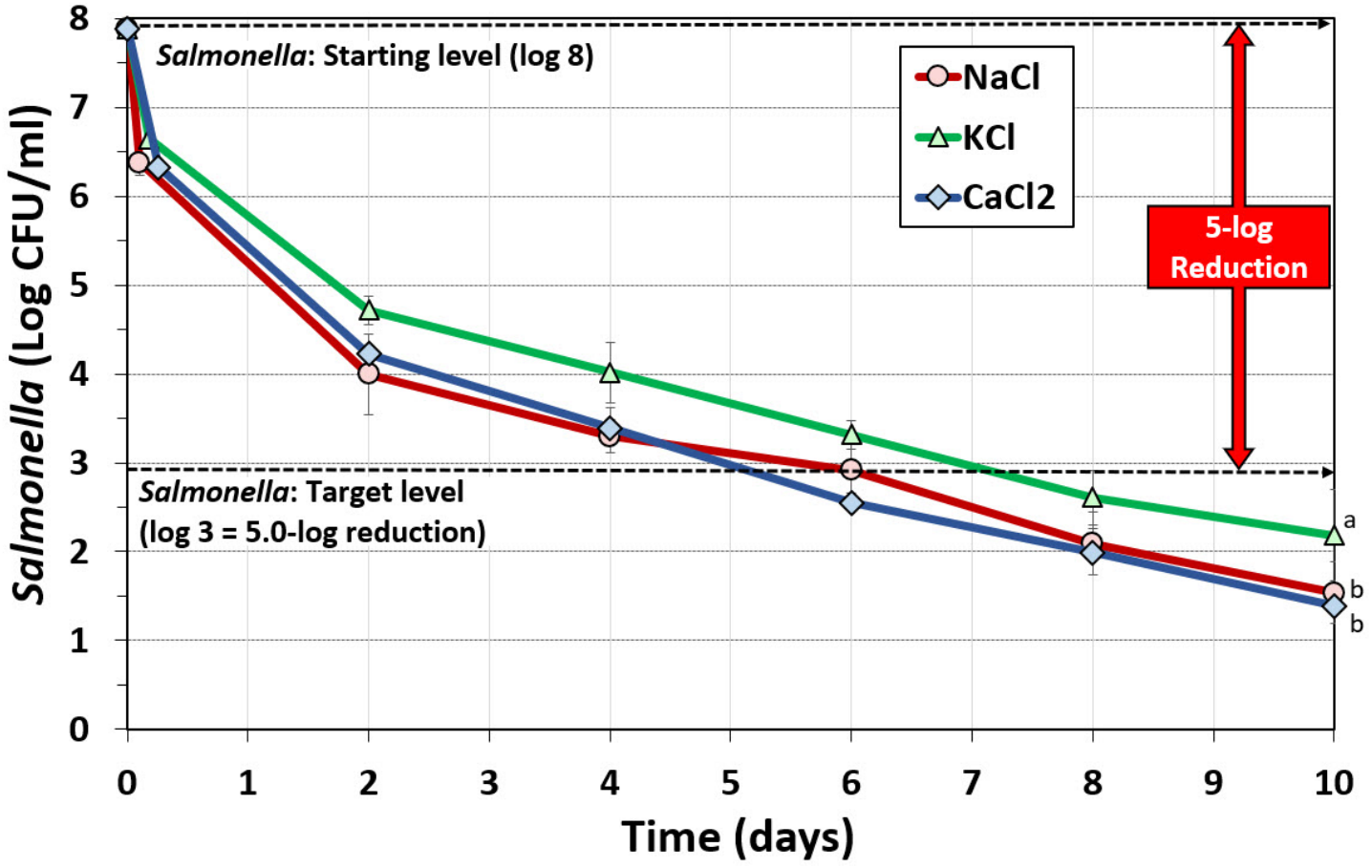
Fabricate/Inoculate beef pieces

Dip in (sterile) Water (30s)

Vacuum Tumble with spice, salt, vinegar (30 min, 15-in Hg)

Hang in drying oven (temp/R/H)

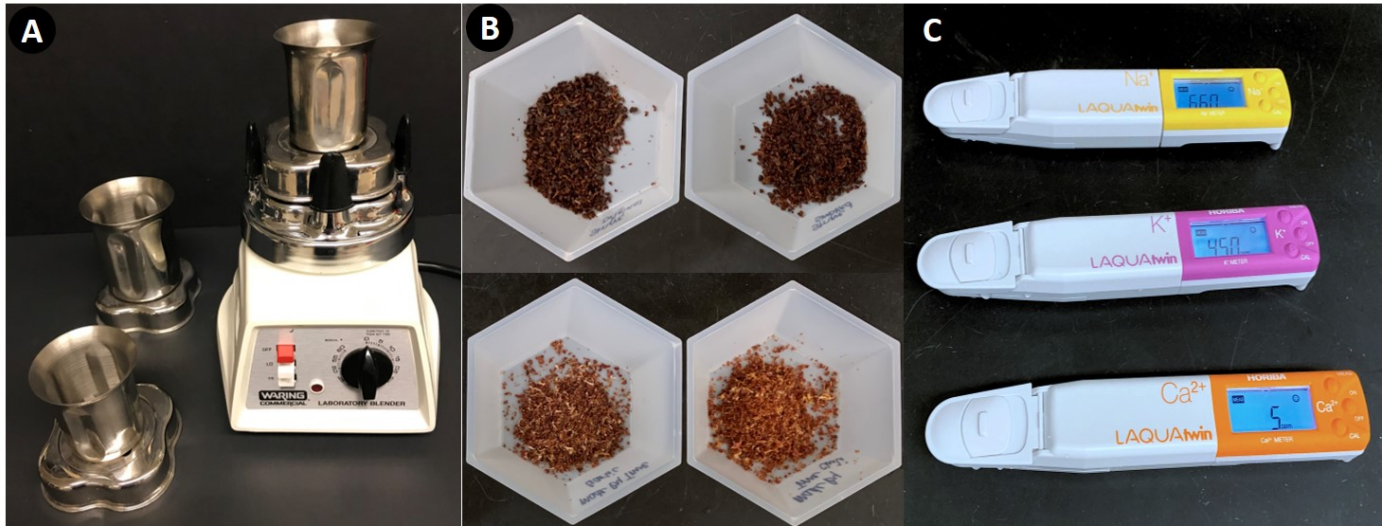
Microbial Enumeration

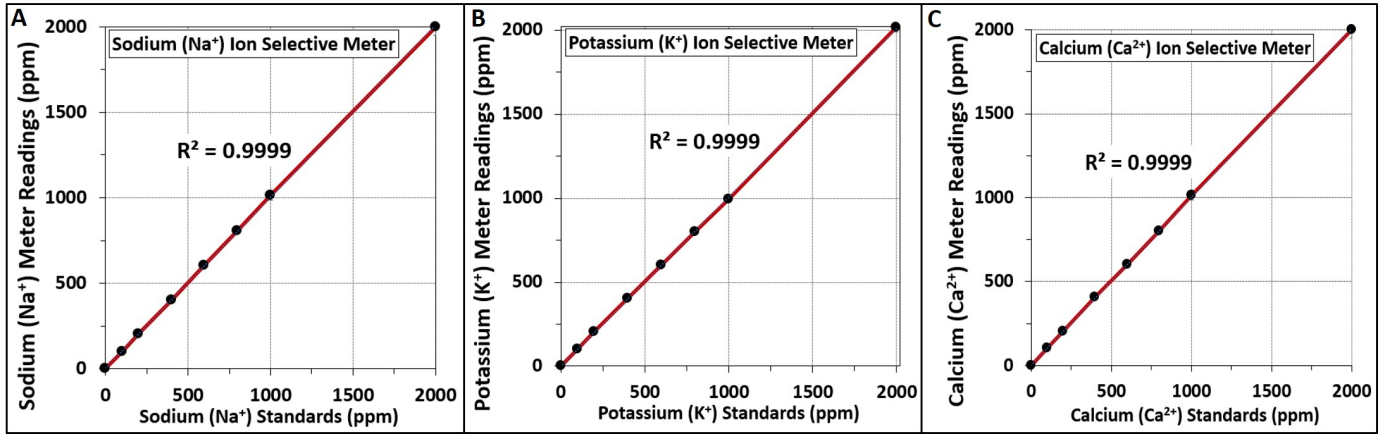


- 5-log reduction achieved by:
  - $CaCl_2$ → Day 6
  - NaCl → Day 7 (via extrapolation)
  - KCl → Day 8
- After 10 days of drying, overall reduction:
  - $CaCl_2$ → 6.37-log
  - NaCl → 6.22-log
  - KCl → 5.57-log
- NaCl and $CaCl_2$ not significantly different; both sig. dif. from KCl

Salt Ion Concentration

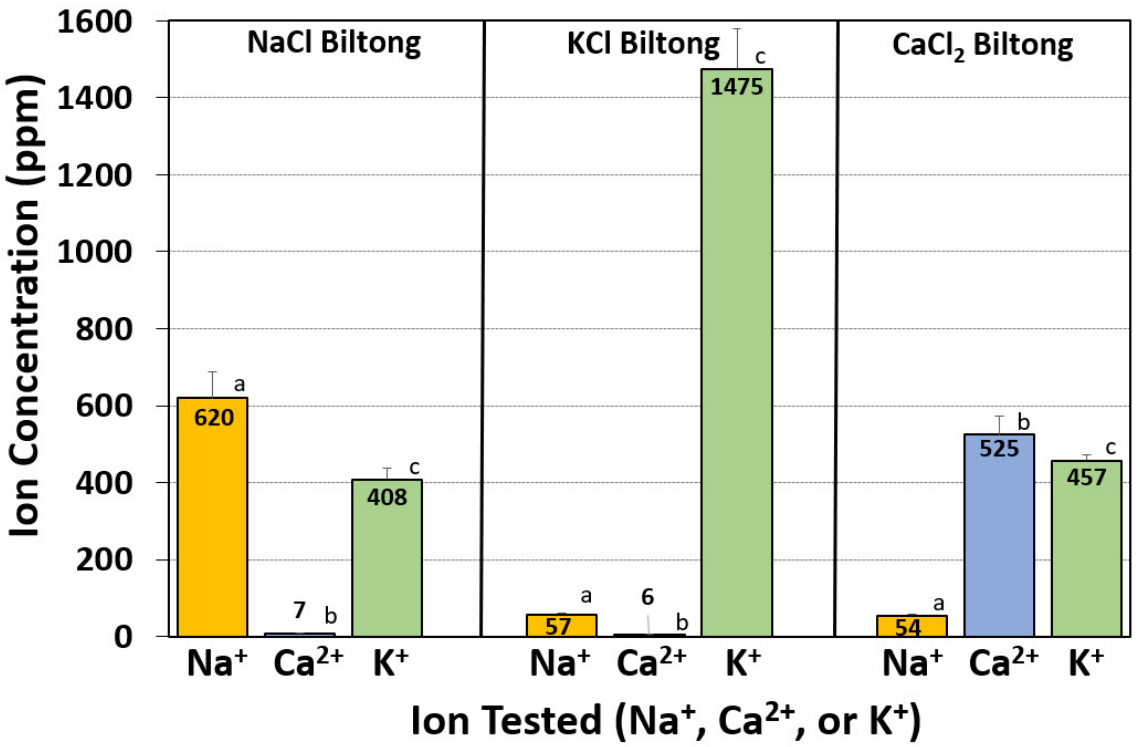
- Sodium, calcium and potassium ion concentrations were measured using ion-specific electrode meters following processing and drying
  - Following drying, biltong pieces were homogenized using laboratory blender
  - 5g of sample was macerated with distilled water in a paddle mixer
  - Each sample was also testing with remaining ion meters to confirm/detect any additional salt ions





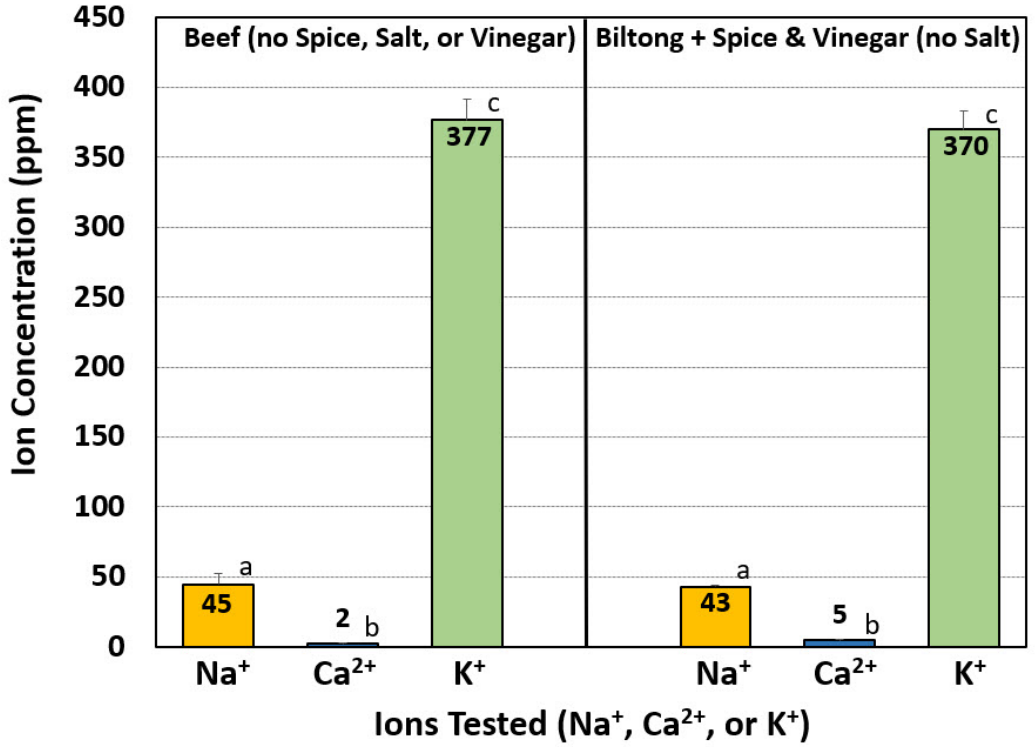
Salt Ion Concentration

Salt Ion Concentrations in Biltong



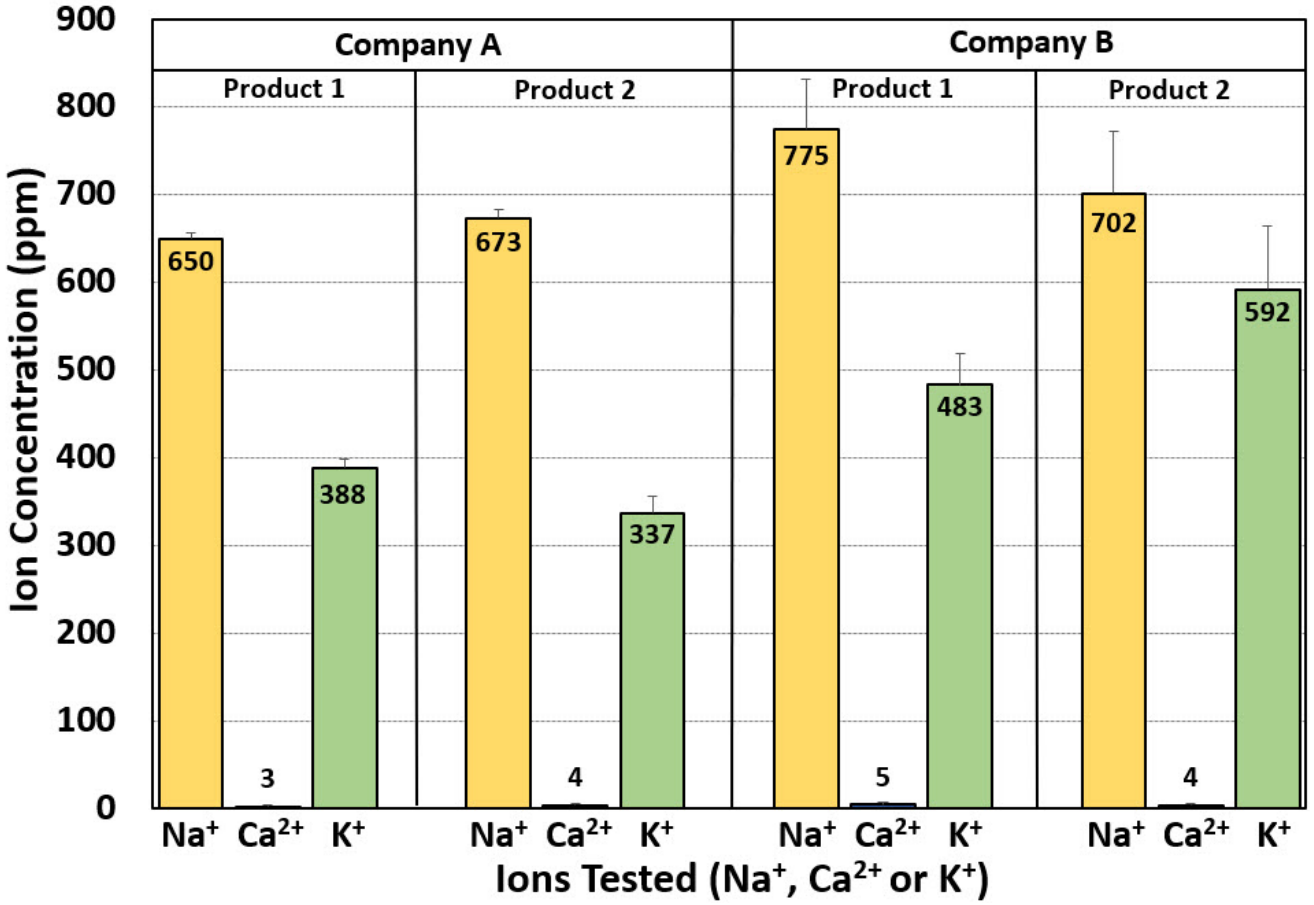
- Ion corresponding to the appropriate salt was most abundant
- K^+ was elevated in all samples

Source of Elevated K^+ Ions



- Source = beef itself was dominate source of K^+

Commercially Available Biltong Comparison



- Compared ion concentrations of commercially available biltong to in-lab manufactured biltong

- Similar levels of K^+ were observed
  - 336-591 ppm = commercial
  - 370-456 ppm = in-lab
- All samples had low levels of Ca^{2+}
- Na^+:
  - 620 ppm = in-lab
  - 650-674 ppm = Company A
  - 702-775 ppm = Company B

Final Conclusions

- Complete substitution of NaCl with KCl or $CaCl_2$ in biltong marinade can achieve a 5-log reduction of *Salmonella*
  - Biltong (made with alternative salts) can be marketed as healthier, low-sodium products
  - Still a microbial safe product
- Additional studies needed:
  - Examine sensory characteristics (including taste, texture and tenderness)
    - $CaCl_2$ and KCl have been associated with off-tastes at high concentrations