Use of Alternative Salts in Biltong Marinade to Reduce Sodium and Still Achieve USDA-FSIS >5-log Reduction of Salmonella
Caitlin Karolenko$^{1,2}$ and Peter Muriana$^{1,2}$

$^1$Dept. of Animal and Food Sciences and the $^2$Robert M. Kerr Food & Agricultural Products Center, Oklahoma State University, Stillwater, OK

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, CaCl₂)
• 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
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 tested 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 = beef itself was dominate source of $K^+$

![Graph showing ion concentrations in different types of biltong](image-url)
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

<table>
<thead>
<tr>
<th>Ions Tested (Na(^+), Ca(^{2+}) or K(^+))</th>
<th>Company A</th>
<th>Company B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na(^+)</td>
<td>650 ppm</td>
<td>670 ppm</td>
</tr>
<tr>
<td>Ca(^{2+})</td>
<td>388 ppm</td>
<td>483 ppm</td>
</tr>
<tr>
<td>K(^+)</td>
<td>337 ppm</td>
<td>483 ppm</td>
</tr>
<tr>
<td>Na(^+)</td>
<td>673 ppm</td>
<td>483 ppm</td>
</tr>
<tr>
<td>Ca(^{2+})</td>
<td>337 ppm</td>
<td>483 ppm</td>
</tr>
<tr>
<td>K(^+)</td>
<td>591 ppm</td>
<td>592 ppm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ions Tested (Na(^+), Ca(^{2+}) or K(^+))</th>
<th>Product 1</th>
<th>Product 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na(^+)</td>
<td>775 ppm</td>
<td>702 ppm</td>
</tr>
<tr>
<td>Ca(^{2+})</td>
<td>483 ppm</td>
<td>592 ppm</td>
</tr>
<tr>
<td>K(^+)</td>
<td>775 ppm</td>
<td>592 ppm</td>
</tr>
</tbody>
</table>
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