POTASSIUM CHLORIDE
AS A SALT SUBSTITUTE
IN BREAD

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AGENDA

• Motivation for work
• Background
• Summary of related work
• Approach
• Results
• Conclusion and significance
MOTIVATION FOR WORK

- Advanced and Experimental Foods
- Michigan Academy of Nutrition and Dietetics Annual Conference
- Salt consumption and health implications
SODIUM – SOURCES AND PHYSIOLOGICAL FUNCTIONS

• Milk, vegetables, water

• Necessary for life!
  • Regulates blood volume
  • Blood pressure
  • Osmotic equilibrium
  • pH
SODIUM – CONVENTIONAL USES

- Preservative in ancient times
- Tanning leather, dying clothes
- Seasoning
- Preservative in processed foods
SODIUM CONSUMPTION

- DRI – 2.3 g/day
  - Current average intake – 3.4 g/day
- The “Salty Six”
EXCESS SODIUM – HEALTH IMPLICATIONS

- Cardiovascular disease
- Kidney disease
- Osteoporosis
- Stomach cancer
- Headaches
POTASSIUM – PHYSIOLOGICAL FUNCTIONS

• Controls blood pressure and counteracts with sodium
  • Aids in relaxing blood vessel walls → decreases BP
• Decreases intravascular volume
  • Increased urinary sodium excretion
POTASSIUM

- RDI – 4.7 g/day
  - Average intake – 2.4-3.2 g/day

- Sources
  - Meat and soy products, broccoli, peas, lima beans, tomatoes, potatoes (with skin), sweet potatoes, winter squash, citrus fruits, cantaloupe, bananas, kiwi, prunes, apricots, milk, yogurt, nuts
BREAD

- Staple in the American diet
- Member of the “Salty Six”
- 80-230 mg of sodium per slice
- Salt necessary for baking process
  - Controls yeast fermentation
  - Effects bread volume
SUMMARY OF RELATED WORK

• “The flavor and acceptability of six different potassium-enriched (sodium reduced) iodized salts: a single-blind, randomized, crossover design.” – Maleki Et Al
  • Tested 0%, 5%, 10%, 15%, 20%, 25%, and 30% potassium chloride concentrations
  • When potassium concentrations were low, no distinguishable difference
  • Number of participants who preferred potassium-enriched salt was greater than those who preferred pure sodium chloride in all concentrations but 10%
SUMMARY OF RELATED WORK

• “Effect of partial sodium chloride replacement by other salts on wheat dough rheology and breadmaking.” – Salovaara H
  • replacing 50% or less of NaCl with KCl had no adverse effects on dough rheology, although it did have a slightly bitter or metallic aftertaste

• “Evaluation of potassium chloride as salt substitute in bread.” – Wyatt CJ, Ronan K
  • No significant differences between the control product (100% NaCl) and the 50:50 ratio breads. The bread found to have the highest acceptability among panelists was one with 75:25% NaCl/KCl ratio.
APPROACH

• Objective - to determine whether or not there are noticeable differences between bread made with 100% sodium chloride and bread made with a percentage of potassium chloride in place of sodium chloride, and to determine if bread made with potassium chloride could be accepted by consumers.

• 3 bread variations
  • 100% sodium chloride (control), 25% potassium chloride, and 50% potassium chloride.
**APPROACH**

- **Subjective tests**
  - descriptive hedonic test for appearance, flavor, texture, and moistness
  - two paired comparison tests for bitterness and saltiness.
  - Sensory tests were performed on fifteen untrained students at Western Michigan University

- **Objective tests**
  - samples analyzed for crust color, contour of surface, crumb color, cell size, thickness of cell walls, and volume.
## RESULTS

### Table 1: Nutrient Analysis of Bread Variations

<table>
<thead>
<tr>
<th>Nutrients Per Serving</th>
<th>Control</th>
<th>25% Potassium chloride</th>
<th>50% Potassium chloride</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>120 kcal</td>
<td>120 kcal</td>
<td>120 kcal</td>
</tr>
<tr>
<td>Fat</td>
<td>3 g</td>
<td>3 g</td>
<td>3 g</td>
</tr>
<tr>
<td>Sugar</td>
<td>2 g</td>
<td>2 g</td>
<td>2 g</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>23 g</td>
<td>23 g</td>
<td>23 g</td>
</tr>
<tr>
<td>Protein</td>
<td>4 g</td>
<td>4 g</td>
<td>4 g</td>
</tr>
<tr>
<td>Sodium</td>
<td>260 mg</td>
<td>198 mg</td>
<td>138 mg</td>
</tr>
<tr>
<td>Potassium</td>
<td>0 mg</td>
<td>108.6 mg</td>
<td>217.3 mg</td>
</tr>
</tbody>
</table>
# RESULTS

## Table II: Objective Testing

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>25%</th>
<th>50%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>External Appearance:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crust Color</td>
<td>- Golden brown</td>
<td>- Darker than control</td>
<td>- Brownish tan</td>
</tr>
<tr>
<td></td>
<td>- Lighter than 50% variation</td>
<td>- Darker in the middle, lighter along</td>
<td>- Lighter than control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>edges</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Darker in the middle, lighter along edges</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Brownish tan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Lighter than control</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Contour of Surface</strong></td>
<td>- Slightly bumpy</td>
<td>- Very bumpy compared to control</td>
<td>- Fairly smooth surface</td>
</tr>
<tr>
<td><strong>Crumb Color</strong></td>
<td>- Light tan</td>
<td>- Light tan, no difference from control</td>
<td>- Tiny bit darker than control</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Internal Appearance:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell Size</td>
<td>- Both small and large cells</td>
<td>- Same as control</td>
<td>- Larger cell sizes than control</td>
</tr>
<tr>
<td></td>
<td>- More small than large cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Same as control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Larger cell sizes than control</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Thickness of Cell Walls</strong></td>
<td>- medium thickness of cell walls</td>
<td>- same as control</td>
<td>- Thicker cell walls than control</td>
</tr>
<tr>
<td></td>
<td>- same as control</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>567 cc</td>
<td>450 cc</td>
<td>700 cc</td>
</tr>
</tbody>
</table>
Table III: Descriptive Hedonic Test Summary

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control</th>
<th>25% Potassium chloride</th>
<th>50% Potassium chloride</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>6.2</td>
<td>6.9</td>
<td>6.2</td>
</tr>
<tr>
<td>Flavor</td>
<td>4.9</td>
<td>5.7</td>
<td>5.0</td>
</tr>
<tr>
<td>Texture</td>
<td>5.4</td>
<td>6.4</td>
<td>5.8</td>
</tr>
<tr>
<td>Moistness</td>
<td>5.2</td>
<td>6.1</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Scale: 1 = Dislike extremely  
2 = Dislike very much  
3 = Dislike moderately  
4 = Dislike slightly  
5 = Neither like nor dislike  
6 = Like slightly  
7 = Like moderately  
8 = Like very much  
9 = Like extremely
RESULTS
RESULTS

Table V: Overall Preference

- Control: 40%
- 25% KCl: 27%
- 50% KCl: 27%
- None: 6%
CONCLUSIONS AND SIGNIFICANCE

- Panelists preferred the 25% potassium chloride variation over the 50% potassium chloride and the control.
- According to the data collected, potassium chloride can be substituted for sodium chloride in whole wheat bread without any noticeable differences in appearance, flavor, texture, or moistness.
CONCLUSION AND SIGNIFICANCE

• Some companies have taken the initiative to reduce sodium content in their products on their own
  • Nestlé - removed roughly 7,500 tons of sodium from their products since 2005
  • Knorr dry soups - reduced their sodium content by 10%
  • Kellogg - reduced sodium content of many of their cereals by 38% over the last decade
CONCLUSION AND SIGNIFICANCE

- reducing sodium content by 20-30% would increase food cost by 5-30% depending on the type of food
- investing 25.5 million dollars on salt reduction efforts could prevent 6,000 deaths due to cardiovascular disease. This would in turn lead to a savings of 500 million dollars per year
  - health and economic benefits of salt reduction in packaged foods would outweigh the cost of recipe reformulation
CONCLUSION AND SIGNIFICANCE

• The best and most efficient way to reduce sodium content in pre-packaged and processed food is to put pressure on the food industry to expand its efforts in reducing the sodium content of foods.

• The human salt taste receptors can adapt over time to lower salt concentrations, making small sodium reductions in processed foods a way to reduce sodium without the reduction being detected by consumers.

• Imperative that we help consumers understand how to flavor unsalted foods with spices and herbs.

• Policies and programs at local, state, and national levels are essential to support reduction efforts. In addition to reducing sodium in processed and pre-packaged foods, labeling of food products needs to improve in order to increase consumer awareness and understanding of sodium in food.
Thank you!


• CNN. Cable News Network. Web. 27 Nov. 2016.


