Challenges of Removing Salt as a Sodium Reduction Solution for Foods

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June 19-21, 2018 Park City UT, USA

Sodium Intake and Health Outcomes

Why the Interest in Sodium Reduction?

41 Million — *Deaths due to noncommunicable diseases (NCD) (71% of all deaths)*

17.9 Million — *Deaths due to cardiovascular disease (44% of NCD)*

1 Billion — *Affected by high blood pressure (hypertension)*

2.5 Million — *Preventable deaths if individuals consume recommended sodium intake of 2000 mg/day (5 g salt)*

Source: WHO, 2018, http://apps.who.int/iris/bitstream/handle/10665/272596/9789241565585-eng.pdf?ua=1

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Drivers for Sodium Reduction

Consumer/Market Trends

- Health & Nutrition
  - Low sodium
- Permissible / Indulgent
  - Sea salt

Policy/Regulation

- Decision makers
  - Government
- Influencers
  - Non-government organizations, academia, food industry

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Primary Sources of Sodium by Geography[1]

Country	Food Source of Sodium (%)
China	Home cooking (76%)
Japan	Four food categories[2] (63%)
United Kingdom	Processed foods (95%)
United States	Processed foods (71%)

[1]Anderson et al. 2010. *J Am Diet Assoc.* 110(5):736-745

[2]Soy sauce (20%), processed fish (15%), salted soups (15%), preserved vegetables (13%)

Salt is a common ingredient and salt reduction is generally the first step for sodium reduction

Processed Food Sources of Sodium

Bakery	Dairy Products	Fermented Vegetables	Meat	Snacks & Cereal
• Inherent in grains • Preservatives • Leavening agents • Reducing/ oxidizing agents • Emulsifiers • Salt	• Milk (intrinsic) • Salt • Emulsifying salts • Preservatives • Flavors or flavor enhancers • Dairy powders • Salt	• Inherent in vegetables • Preservatives (e.g. sodium benzoate) • Color retention agents • Salt	• Meat (intrinsic) • Preservatives • Phosphates • Non-meat proteins • Seasonings • Salt	• Flavors or flavor enhancers/ carriers • Buffering agents • Salt

- ***Salt is commonly used in all of these food sources***

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Functional Role of Salt in Foods

- Microbial Management
  - Impacts water activity (Aw)
  - Organisms sensitive to Aw
- Protein Modification
  - Structure
  - Physical properties
- Sensory Attributes
  - Taste:
    - Salty and flavor enhancement
  - Texture
  - Quality

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Microbial Management

Addition of salt to foods:

- Decreases water activity (Aw), a tool to control growth of microorganisms
- Meat applications: prevents growth of spoilage organisms (Table 1)
- Yeast leavened products: controls yeast fermentation for desired gas formation (Figure 1 and Figure 2)
- Fermented products (meats, vegetables, cheese): creates environment for desired microorganism

Table 1. Effect of salt on roasted chicken shelf-life[1]

Percent Sodium Reduction (mg sodium/100 g meat)	Growth Time: Log 2 to Log 4 (days)[2,3]	Lag Time (days)[2,3]
0 (910)	70-100	31-89
25 (670)	65-93	28-83
50 (470)	58-84	25-75

Figure 1. Effect of Salt (NaCl) and Potassium Chloride (KCl) on Bread Proof Time (Volume Height)[1]

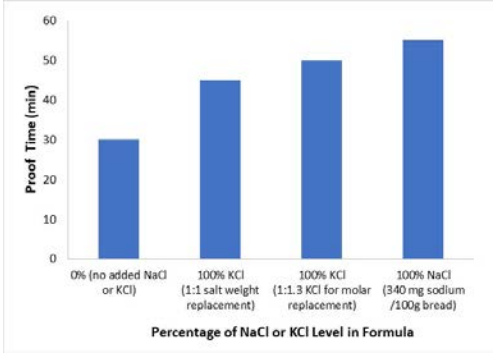
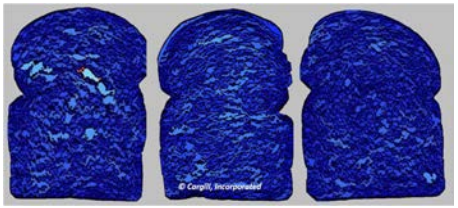


Figure 2. Effect of Salt (NaCl) Level on Air Cell Distribution (C-Cell) in White Bread[1]



0% 50% 100% (340 mg sodium/ 100g bread)

Salt Level (% of full control formulation)

[1]Cargill, Inc., proprietary research
[2]Opti.Form® Listeria Control Model 2007 – theoretical model
[3]First and second value at 99% and 95% confidence, respectively

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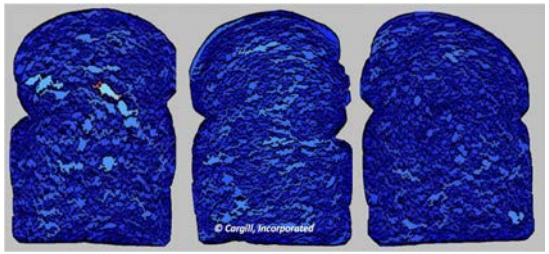
Protein Modification

Addition of salt to foods:

- Alters secondary and tertiary structure of proteins, and protein-protein interactions
- Cheese applications: increases protein hydration, which impacts texture, rheology and melting characteristics
- Bakery applications: decreases gluten formation, but also increases gluten strength
- Meat applications: extracts and helps solubilize myofibrillar proteins (Figure 3). Increases water holding capacity and improves texture.

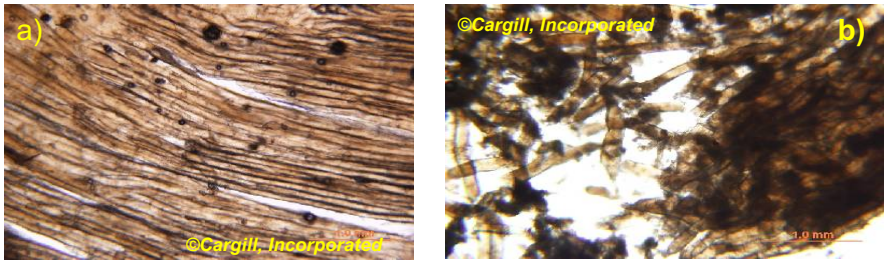
Figure 2. Effect of Salt (NaCl) Level on Air Cell Distribution (C-Cell) in White Bread[1]



0% 50% 100% (340 mg sodium/ 100g bread)

Salt Level (% of full control formulation)

Figure 3. Effect of Salt (0 and 2% w/w) on the Myofibril Protein Swelling and Structure in Deli Hams[1]



a) salt added at 2% (wt/wt), b) no added salt (0% wt/wt).

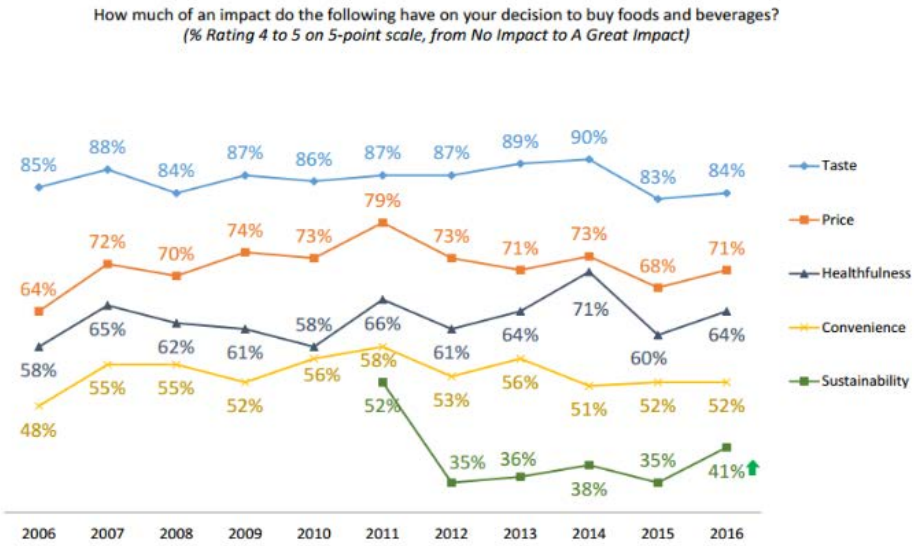
[1]Cargill, Inc., proprietary research

Sensory

Addition of salt to foods:

- Taste number one driver for consumer purchase intent
- Provides salty taste and flavor enhancement, suppresses undesirable flavors
- Impacts Aw – flavor and acid production by organisms
- Impacts protein structure (texture)
- Gradual salt reduction and consumer acceptance is application specific[1]
- Other chloride salts (potassium, calcium and magnesium) similar to sodium, but adds bitter/off notes in some applications (e.g. cheese[2])

[1]Drake et al. 2011. *J Dairy Sci.* 94(2):636
[2]Grummer et al. 2012. *J Dairy Sci.* 95:2830



Source: International Food Information Council Foundation. 2017 Food & Health Survey: A Healthy Perspective: Understanding American Food Values.

No other single ingredient replicates all the sensory attributes of salt.

Conclusions

- Government and non-government organization continue to encourage food industry to decrease sodium in foods
- Salt has many functional roles (e.g. microbial management, protein modification, sensory) in foods, making it a significant tool for product developers
- Gradual salt reduction may help with consumer taste acceptance, but too low of a salt level impacts other attributes
- No single ingredients performs all the functional roles of salt, which adds to the challenges of reformulation
- Additional research required to overcome technical challenges, especially the area of salty taste receptors

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Questions

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