WORLD SALT SYMPOSIUM

June 19-21, 2018 Park City UT, USA

# Salt with Differentiated Adhesion Promoters for Topical Snack Applications

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- Background
- Methodology
- Tools
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- Conclusion

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# Adhesion Improvements Topical Delivery: Benefits & Value

*Improve Salt Adhesion by Modification with Polysaccharide Based Coatings*

| | |
|---|---|
| Sodium Reduction | **Reducing salt fall off within packaging**<br>**Lowering sodium content per serving** |
| Efficiency & Sustainability | **Improving adhesion results in less salt loss and waste generation for food manufacturers** |
| Clean Label | **Natural, naturally derived, non-GMO and food grade** |

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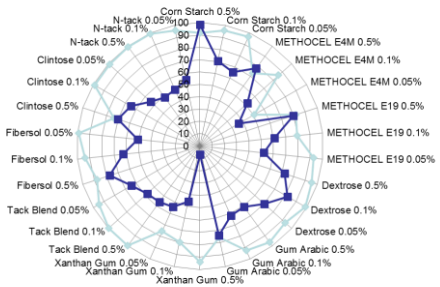
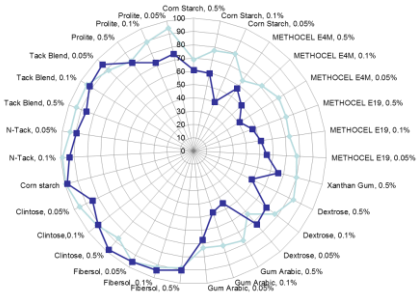
# Factors Impacting Adhesive Between Salt Particle and Substrate

## Baked Chips (Blue) and Fried Chips (Light Blue)




Modified Salt A




Modified Salt B

| | |
|---|---|
| Concentration | 0.05-0.5 Wt. % |
| Particle Size/Surface | Gravitational, Surface forces (Capillary, Hydrogen Bonding, Van der Waals) |
| Promoter Structure | Molecular weight, Branching, Substitution |

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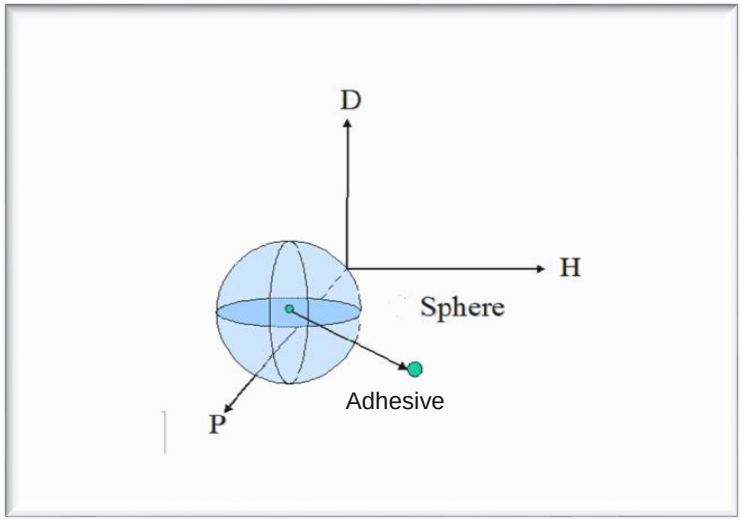
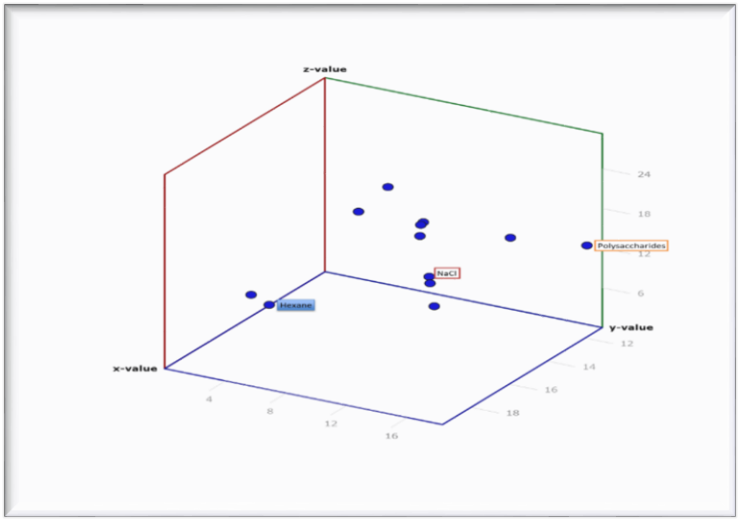
# Tools to Evaluate Adhesion: Hansen Solubility Parameters (HSP)




δD Dispersion (Van der Waals); δP (Polarity); δH (Hydrogen Bonding)




Hansen Solubility Parameters of Salt and Adhesion Promoters

HSP and Radius of Interaction for Salt

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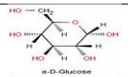
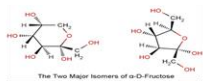
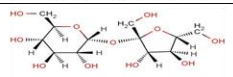
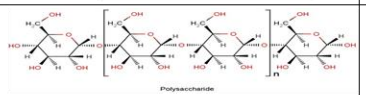
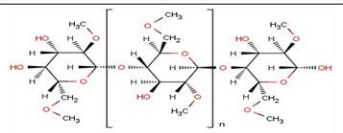
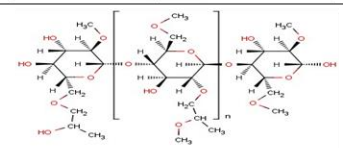
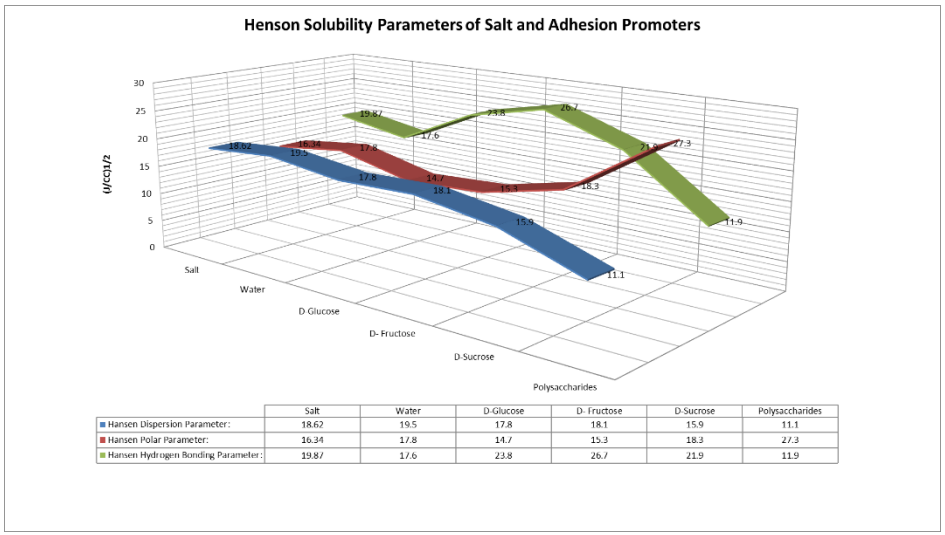
# Calculated HSP Values of Select Adhesion Promoters

| CHEMICAL STRUCTURE | SOLUBILITY PARAMETERS, (J/cc)1/2 Dispersion, Polar, Hydrogen Bonding |
|---|---|
| Sodium Chloride | 18.62, 16.34, 19.87 |
| Water | 19.5, 17.8, 17.6 |
|  α-D-Glucose | 17.8, 14.7, 23.8 |
|  The Two Major Isomers of α-D-Fructose | 18.1, 15.3, 26.7 |
|  Disaccharide | 15.9, 18.3, 21.9 |
|  Polysaccharide | 11.1, 27.3,11.9 |
|  Methylcellulose | 17.4 - 18.3, 14.6 - 16.5, 15.1 - 19.4 |
|  Hydroxypropyl Methylcellulose | 17.4 - 18.3, 14.6- 16.5 15.1 - 19.4<br>High Hydroxy Propyl Substitution<br>17.3, 9.9, 13.5 |




| | Salt | Water | D-Glucose | D- Fructose | D-Sucrose | Polysaccharides |
|---|---|---|---|---|---|---|
| Hansen Dispersion Parameter: | 18.62 | 19.5 | 17.8 | 18.1 | 15.9 | 11.1 |
| Hansen Polar Parameter: | 16.34 | 17.8 | 14.7 | 15.3 | 18.3 | 27.3 |
| Hansen Hydrogen Bonding Parameter: | 19.87 | 17.6 | 23.8 | 26.7 | 21.9 | 11.9 |

**Adhesive that met defined solubility criteria determined for salt selected**

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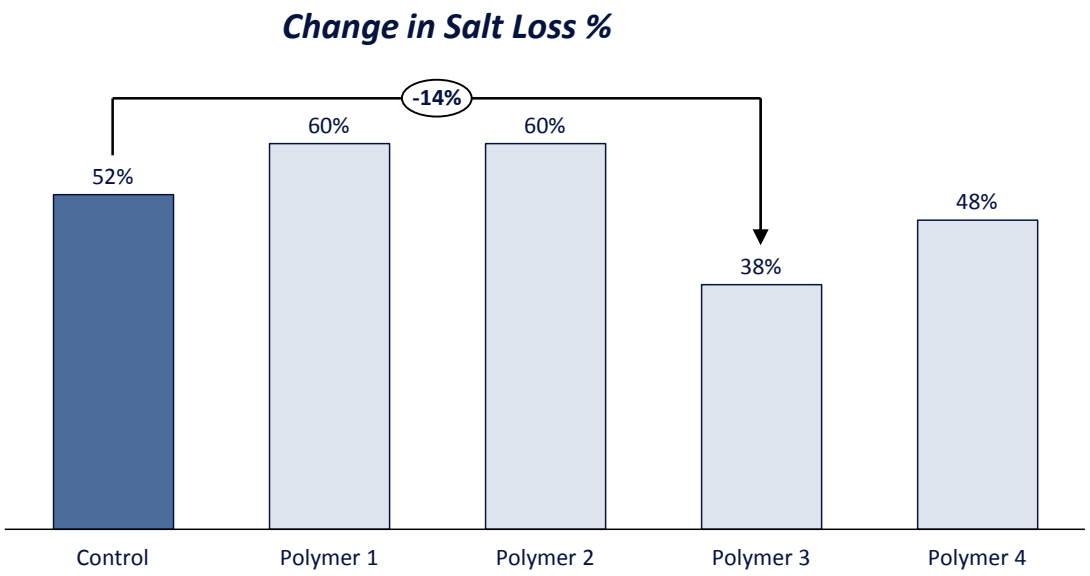
# Influence of Polymer Structure on Adhesion

***Addition of Polymer to Salt Reduces Total Salt Loss by 14%***




Adhesion Greatest for Non-substituted Linear Molecules

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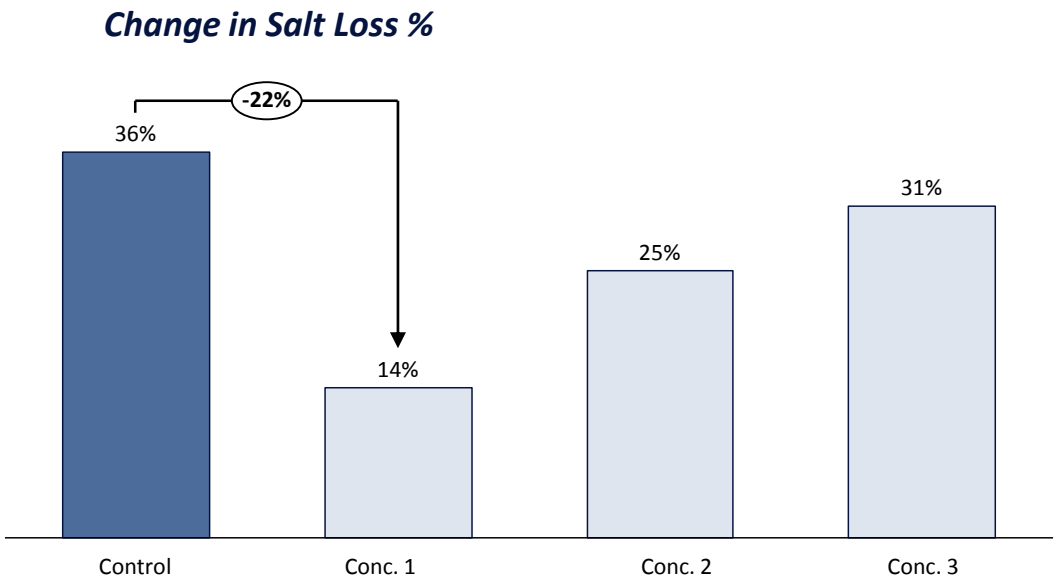
# Impact of Polymer Concentration on Adhesion

***Varying Polymer Concentration Reduces Salt Loss on Topical Applications***




Reduction Total Salt Loss by roughly 20%

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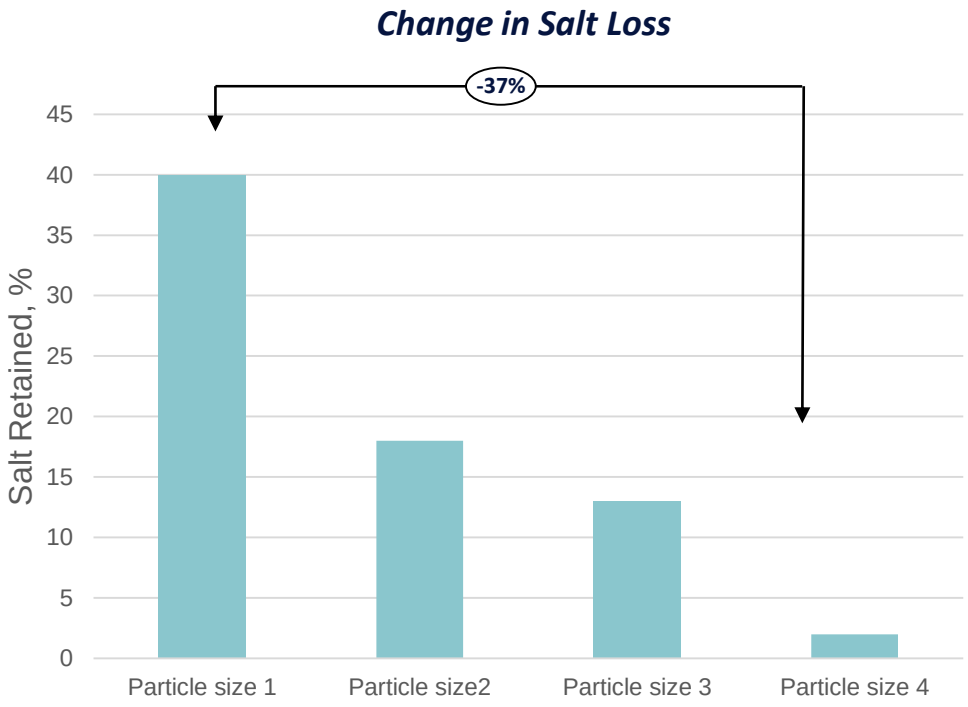
# Influence of Particle Size of Salt with on Adhesion

***Various Particle Size Salt with Adhesion Polymer Impacts Adhesion Efficiencies***




Salt Loss Increases as Particle Size Increases

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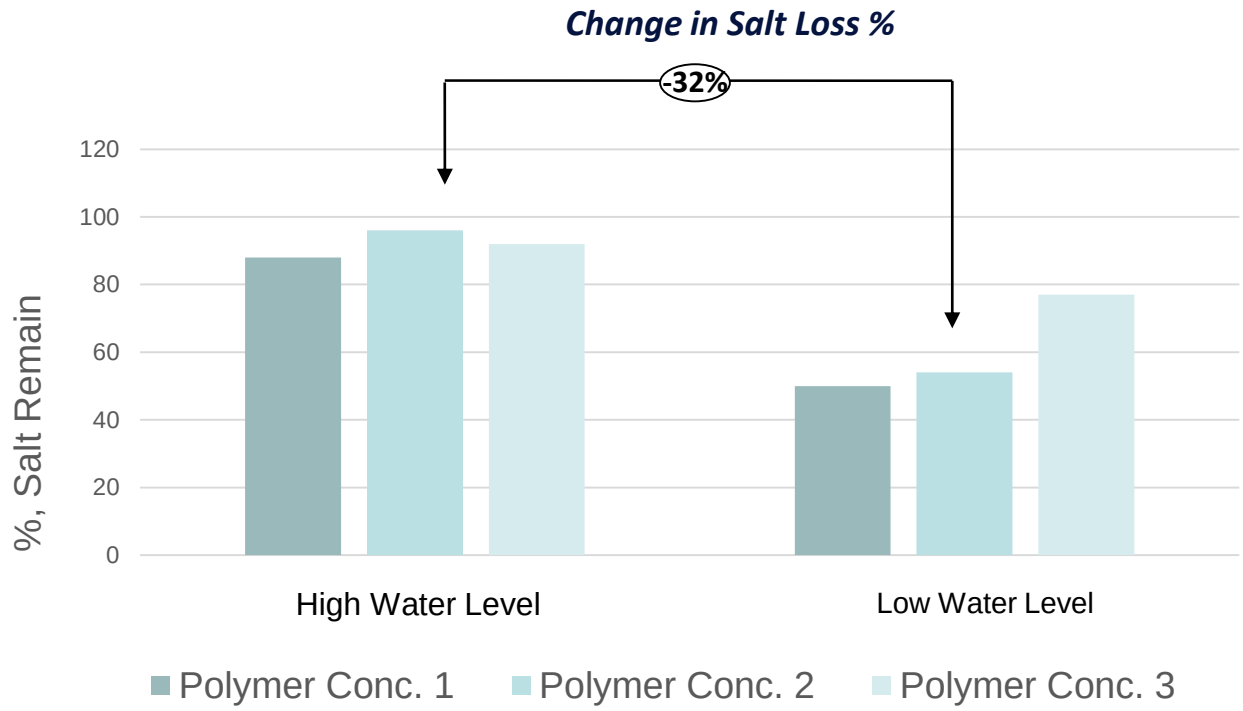
# Influence of Water and Polymer Concentration on Adhesion

***Addition of Water to Salt Impacts Total Salt Loss by as much at 32%***

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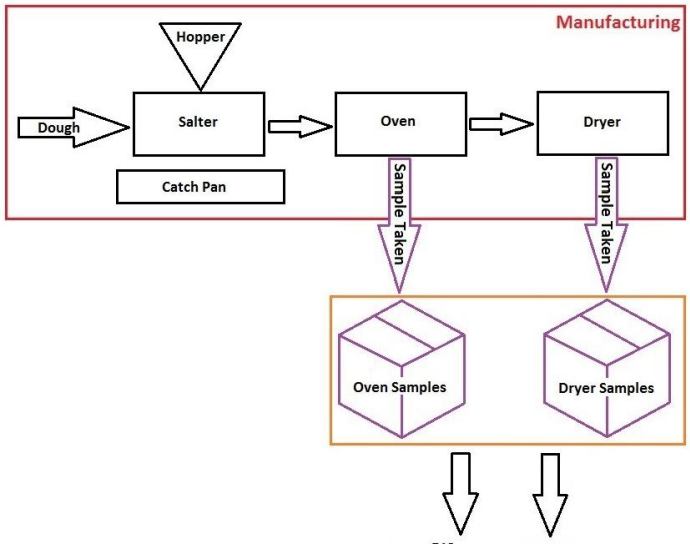
# Scale-Up of Laboratory Developed Process




| | |
|---|---|
| Salt Application Rate/ Salting Rate | Salt collected on a pan in one minute (grams salt collected/minute) |
| Salter Speed % | Adjusted to desired Rate (Low and High) |
| Oven and Dryer Output | Samples collected at two locations |

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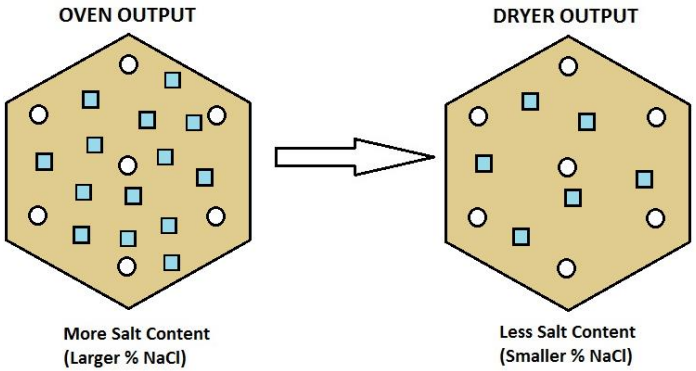
# Method/Terminology for Salt Loss Testing

EXAMPLE




| | |
|---|---|
| Instrument: DiCromat | Calculated the amount of salt that adhered to application |
| Calibration Instrument | [mass salt (g)/mass crackers (g)] * 100 = % NaCl |
| Salt Lost | Determine amount of salt lost from conveying from the oven to dryer |
| Oven and Dryer Output | All salt content data is normalized to the catch pan mass per minute |

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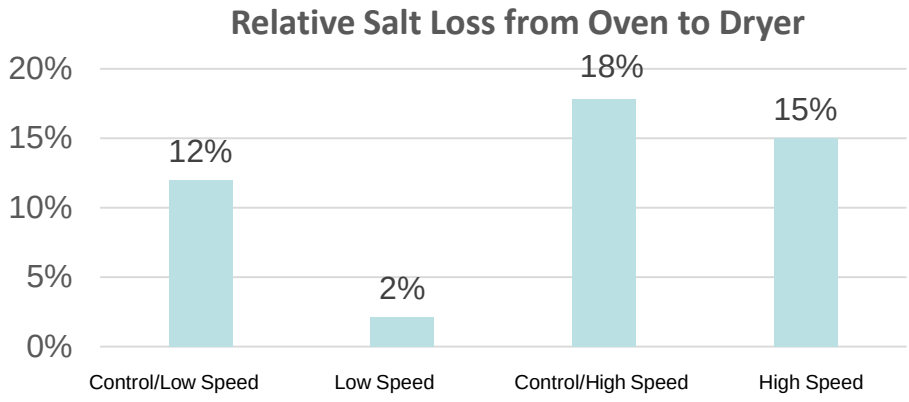
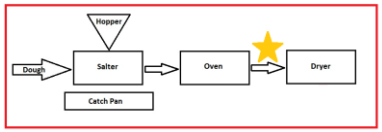
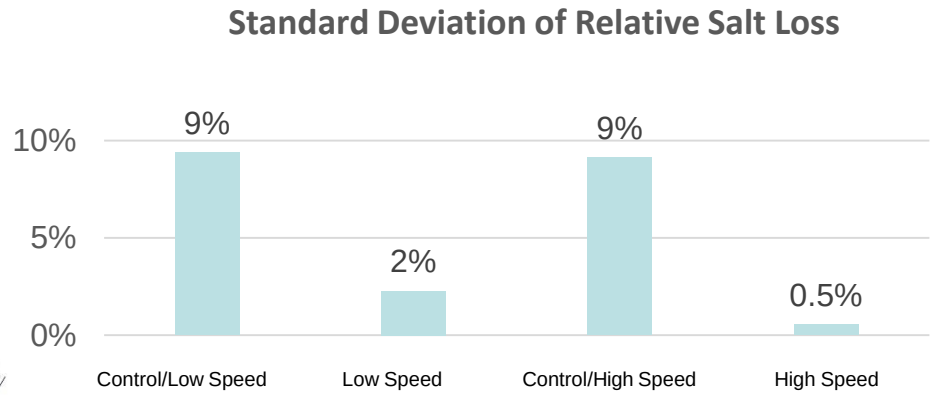
# Relative Salt Loss from Oven to Dryer




**Relative Salt Loss Calculation:**

$$\frac{\text{Oven} - \text{Dryer}}{\text{Oven}}$$

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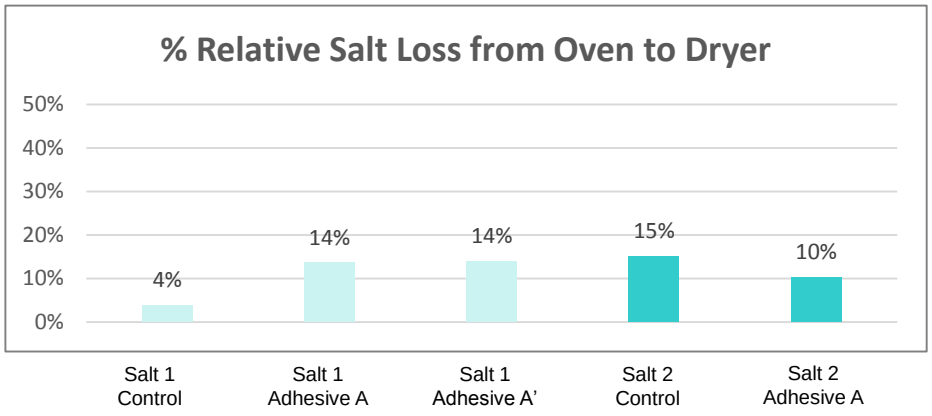
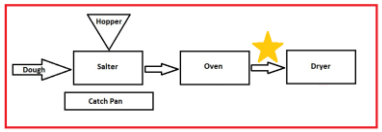
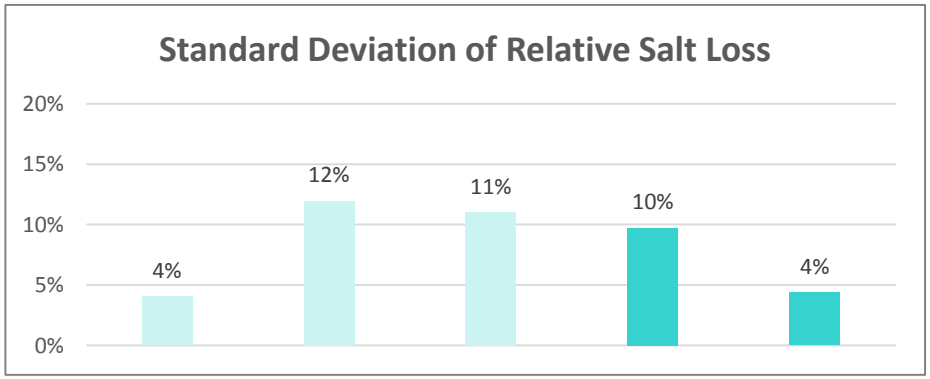
# Relative Salt Loss from Oven to Dryer (Low Speed)




**Relative Salt Loss Calculation:**

$$\frac{\text{Oven} - \text{Dryer}}{\text{Oven}}$$

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# Conclusions

- Modified salts with polysaccharides may have significant impact on adhesion efficiency topical applications
- Adhesion efficiency influenced by topical application and particle size salt crystal
- Adhesion efficiency influenced by modifying interfacial properties between salt crystal, adhesive and substrate
- Modified salts may provide efficiency benefits to manufacturers with improved adhesion and process control
- Improved adhesion efficiency may result in improved sodium reduction per unit of packaging in topical applications

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# Questions ?

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