

Science of Taste Modification: Salt Reduction

*Dr. Robert Sobel, Vice President Research,
Quality & Innovation
Erin Burnside,
Technology and Innovation Research Assistant*

Introduction

Saltiness is one of the five established basic tastes; it is sensed by the passage of sodium ions through channels in the surface of the tongue. Although humans appear to have a liking for salt taste, overconsumption of salt is responsible for a number of serious health problems, and as a result, the World Health Organization (WHO) is recommending a reduction of sodium in the diet by 50% or more¹. Because only a small amount of the salt found in a U.S. diet is discretionary — i.e. added by the consumer — there is a lot of pressure on members of the food industry to find ways to reduce sodium in their products. In order to do this, it is necessary to explore ways to make foods that seem sufficiently salty to consumers while still reducing the actual sodium content.

Physical Structure

One possible route for salt reduction is to change the physical structure of the salt itself or the salted food; this can alter how the salt interacts with the tongue. One area that seems promising is addition of tasteless, safe materials to the salt in order to allow for a smaller salt particle size without agglomeration of the salt during storage. These smaller particles dissolve more rapidly in saliva and are able to be sensed more rapidly and with greater initial intensity as a result.

Both SALiTe™ and Soda-Lo® are products that utilize this strategy. SALiTe™, which is recommended for surface applications, processes a mixture of salt and a bulking agent until they reach an appropriately small size². Soda-Lo® uses atomization of an aqueous salt solution with added organic material to create hollow salt spheres that are well-suited for use in bread³. Both create salt particles on a micron or smaller scale, and both boast a salt reduction of at least 50% in some tested cases. Alternatively, the structure of the food itself can be reexamined; in one study of saltiness perception in bread, creating contrasting low- and high-salt regions in the loaf allowed for a reduction of salt by 50% without a significant difference in perceived saltiness⁴.

Phantom Aromas

Another possibility is the use of phantom aromas, odors at or below the detection threshold, to enhance the perception of salty taste. This has been well-established for sweet taste, but has only recently been investigated for saltiness. Lawrence et al. found that some odors, specifically sardine and ham, increased saltiness perception in a salt-free water solution⁵. Sardine aroma was again found to enhance saltiness when it was applied in a more complex food matrix, a model cheese system⁶. This increase has recently been shown to be dependent on salt concentration — products with low and moderate salt concentrations are more significantly enhanced by phantom aromas than those with more salt⁷.

Congruent Flavors

In addition to phantom aromas, which must be added in low concentrations to prevent changing the overall flavor profile, some research has been done on adding larger amounts of flavors that are the same as or similar to flavors already present in the food. Batenburg and van der Velden compared chicken and beef broths with full salt to those with a 30% salt reduction but additional chicken or beef broth flavor. The stronger broth flavors restored much of the lost saltiness when added alone and all of the saltiness when used with a small amount of a more traditional, mineral-based salt replacer⁸. A Japanese study that looked at dried bonito stock as a congruent flavor found it could compensate for a loss of up to 10% of the sodium in an egg custard while simultaneously improving palatability⁹.

Umami Compounds

Some studies have shown that compounds more typically associated with the umami taste modality may in fact enhance salt perception, as well. For instance, Kremer et al. examined a substitution of soy sauce for simple table salt in salad dressing, tomato soup, and stir-fried pork. They found that by including the umami compounds and salty aromas of soy sauce they were able to reduce actual salt content by 50% in dressing, 17% in soup, and 29% in pork¹⁰.

Combination of Effects: Plant Salt Substitutes

Spray-dried extracts of a number of plants were tested for their perceived saltiness. A composite powder made up of saltwort, sea tangle, and kukoshi was designed and designated the plant salt substitute (PSS). This PSS was able to create the same intensity of saltiness with only 57% of the sodium of standard table salt. This likely combines a number of the strategies described above, by containing both low-concentration (phantom) and high-concentration (congruent) aromas as well as an umami taste attribute¹¹.

Conclusions

Goals of worldwide sodium reduction will require increasingly innovative solutions. No single solution will be able to solve every problem — phantom aromas may work well in low-salt applications, for instance, but a different approach is likely needed for products that are higher in salt — and many of the most successful solutions will likely, as with the plant salt substitutes, combine a number of approaches.

References

- ¹World Health Organization. *Reducing Salt Intake in Populations*. Geneva: WHO, 2007.
- ²S.K. Patil & Associates. SALiTe™: A Novel Safe Low-Salt Solution. Munster, IN: 2011.
- ³Minter, S.J., and S. Maude. Salt Product. Patent US 2011/0098365 A1. 28 Apr. 2011.
- ⁴Noort, M.W.J., et al. "Saltiness Enhancement in Bread by Inhomogeneous Spatial Distribution of Sodium Chloride." *Journal of Cereal Science* 52 (2010): 378-86.
- ⁵Lawrence, G., et al. "Odour-Taste Interactions: A Way to Enhance Saltiness in Low-Salt Content Solutions." *Food Quality and Preference* 20 (2009): 241-8.
- ⁶Lawrence, G., et al. "Using Cross-Model Interactions to Counterbalance Salt Reduction in Solid Foods." *International Dairy Journal* 21 (2011): 103-10.
- ⁷Nasri, N., et al. "Cross-Modal Interactions between Taste and Smell: Odour-Induced Saltiness Enhancement Depends on Salt Level." *Food Quality and Preference* 22 (2011): 678-82
- ⁸Batenburg, M., and R. van der Velden. "Saltiness Enhancement by Savory Aroma Compounds." *Journal of Food Science* 76 (2011): S280-8.
- ⁹Manabe, M. "Saltiness Enhancement by the Characteristic Flavor of Dried Bonito Stock." *Journal of Food Science* 73 (2008): S321-5.
- ¹⁰Kremer, S., J. Mojet, and R. Shimojo. "Salt Reduction in Foods Using Naturally Brewed Soy Sauce." *Journal of Food Science* 74 (2009): S255-62.
- ¹¹Lee, G-H. "A Salt Substitute with Low Sodium Content from Plant Aqueous Extracts." *Food Research International* 44 (2011): 537-43.