IFIS core food information

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Salt reduction

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Cindy heads the Sensory, Consumer and Market Research platform at Leatherhead and sits on the company's Executive Committee. The platform is structured around four teams: Confidential Client Projects, Consumer Operations, Strategic Insights and Applied Research. Cindy's role involves supervising sensory related activities, setting the strategic direction for the team and transferring generated knowledge to Leatherhead's clients. In 2011 Cindy launched the successful SenseReach™ consumer insight tool which gives clients instant consumer feedback on food and non-food products. She has a degree in Food & Business (Heerlen, The Netherlands) and has gained considerable experience working in the food and ingredient industry in companies such as Mars (Netherlands, Germany) as a Sensory Technologist and Danisco (The Netherlands, France & United Kingdom) as a Flavourist. Cindy joined Leatherhead in 2007.

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Abstract

The article will describe how salt is perceived in different product types. Different approaches to reduce salt are discussed, including the usage of salt replacers and enhancers, gradually reducing salt, exploring options of the application of different salt formats and opportunities to use processing and product structure to reduce the salt content of foods.

1. Introduction

Salt reduction has been embraced by the food industry for a considerable time. Many solutions have been developed, often specific to a certain product category, reflecting the product specific challenges for food producers with no one-size-fits-all solution as yet available. Further investigations are continuing to take place by ingredient suppliers and food manufacturers. Whilst reformulating food products, it is important to understand the ingredient interactions within the product and to consider the sensory perception, food safety, processing and quality aspects.

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2. Salt perception

Salt (sodium chloride) has its own taste that we are all very familiar with and is classified as one of the five basic tastes (sweet, salt, sour, bitter and umami). Although other chemicals can also give a salty taste, sodium chloride is generally recognised as a pure salty taste. Salt, like the other basic tastes, forms the foundation for the overall flavour response, created by a combination of the basic tastes, odour volatiles and trigeminal (irritant) response.

Salt is also important as a flavour enhancer in foods, in particular for savoury foods, but also in sweet foods such as chocolate. Removal of salt may make foods bland and unappetising.

Salt also tastes sweet at low concentrations (Figure 1), suppresses bitterness, gives fullness / thickness in foods and in some products is important for its visual crystal appearance. At higher concentrations salt stimulates salivation.

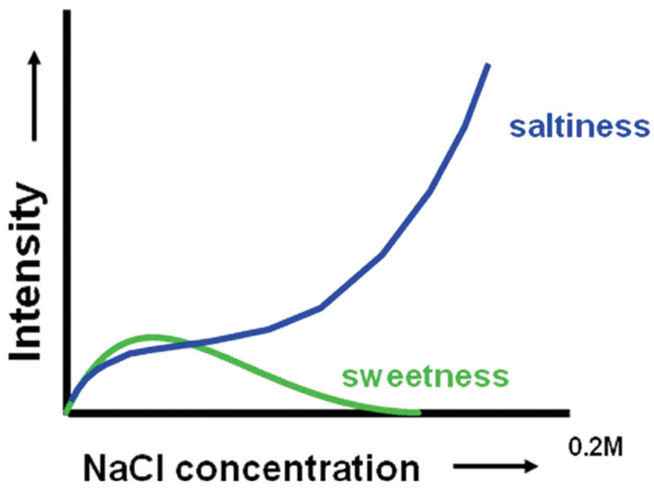

Figure 1: Taste Profile Sodium Chloride adapted from Dzendolet E., Meiselman H. L., 1967, *Perception & Psychophysics*, 2, 29-33

3. Stealth

Many food producers and industries have been successful with the reduction of salt by stealth. The idea of this is a very gradual reduction allowing consumers' taste buds to become accustomed to the lower level of salt in the food without rejecting it. Stealth could be applied for products with strong brand loyalty or alternatively an industry wide approach could be followed. The hypotheses behind stealth is that following a lower salt diet, adaptation takes place and a shift in preference for lower levels of salt.

4. Salt replacers and enhancers

There are many salt replacers available. Of these, the most widely and most commonly used salt replacer is potassium chloride, and many products that are on the market use this as a partial replacer. However, potassium chloride does not have the same flavour profile as sodium chloride, particularly as it gives a bitter taste perception when applied at higher concentrations (Figure 2).

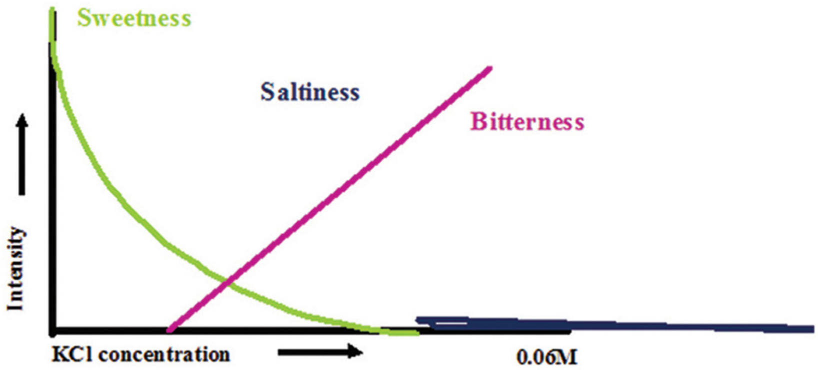

Figure 2: Taste Profile Potassium Chloride adapted from Dzendolet & Meiselman, 1967

Another approach to salt reduction is to use salt enhancers. Salt enhancers are substances that do not have a salty taste in themselves, but enhance a salty taste when used in combination with sodium chloride. A range of ingredients are reported to act as salt enhancers including amino acids, monosodium glutamate, lactates, yeast products and other flavourings. Taste enhancers work by activating receptors in the mouth and throat, which helps compensate for the salt reduction and enhances flavour.

5. Interaction of senses and the use of flavourings

Flavour companies have been actively researching the effect of salt in different application areas. When the salt is reduced, some flavours can effectively build back the aspects that are missing. It is also possible to use other fermentation-derived materials to boost richness and depth of flavour when sodium is lacking.

Another approach to salt reduction could be odour induced saltiness enhancement by a salty-congruent odour. Selected odours can be used to compensate for salt reduction. The five human senses that we use for food evaluation (sight, taste, smell, touch and hearing), interact with each other and can trick our senses in their perception of certain stimuli. It has been suggested that saltiness could be enhanced for example by cheese odour (Pioneer *et al.*, 2004) and Soy sauce (Djordjevic *et al.* 2004).

In some cases, the ratings of saltiness of food products is affected simply by the names of the food products, even prior to tasting. In a study by Lawrence (2009), anchovy and bacon items were considered to be the most salt associated food names.

6. Salt dissolution

Similar to the other basic tastes, we perceive salt with our taste buds, which are distributed over our tongue, palate and throat. The salt particles require dissolution before we can perceive them. In liquid products, salt is thus more readily perceived than in solid products as the solid foods need to be suitably chewed and mixed with our saliva in order for the salt to reach our taste buds.

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A study by Phan *et al.* (2008) demonstrates that the quantity of salt released from a soft cheese is higher than the quantity of salt released from a hard cheese. The maximum concentration of released sodium appeared higher for model cheeses with a lower fat content / water ratio, whereby for this study with processed cheese, the sodium release during mastication appeared particularly enhanced by the water content in the matrix structure and limited by the presence of fat.

In addition, the same study showed that the amount of sodium released from model cheeses was variable between assessors and ranged between 5 and 30% of the total quantity in the model cheeses. Assessors with high salivary flow rate and high masticatory performance experienced a higher sodium release and perceived saltiness more readily.

Any salt in the food that is not well mixed with the saliva will thus be swallowed without perceiving it. Using ingredients that dissolve readily (e.g. starch based thickeners) could enhance salt perception in the food.

7. Salt structure

As well as the enhancement of salt perception by the amount of dissolution of sodium chloride in our saliva, the rate at which this dissolution occurs can also alter our perception of saltiness. A rapid dissolution rate can intensify saltiness in some foods and thus reduce the levels of sodium chloride required.

In solid form, the rate of dissolution of sodium chloride can be controlled by a difference in the exposed surface area of the salt crystals; the particle size and the crystal structure. Dendritic salt for example has voids throughout the crystal, thus drastically increasing exposed surface area, increasing the dissolving rate (Bravieri, 1983).

A study looking into particle size was carried out by Leatherhead (Angus *et al.*, 2005) comparing the saltiness perception of different sodium chloride structures when applied to crisps over time. The sodium chloride types used in this research included table salt (Figures 3a and 3b), salts with different structures, fine salts and freeze dried salts with amorphous type structures. The results from this time intensity experiment confirmed that smaller particles sizes have a more rapid release and an overall higher salt intensity. Maximum salt intensity was reached sooner for the smaller particle sizes.

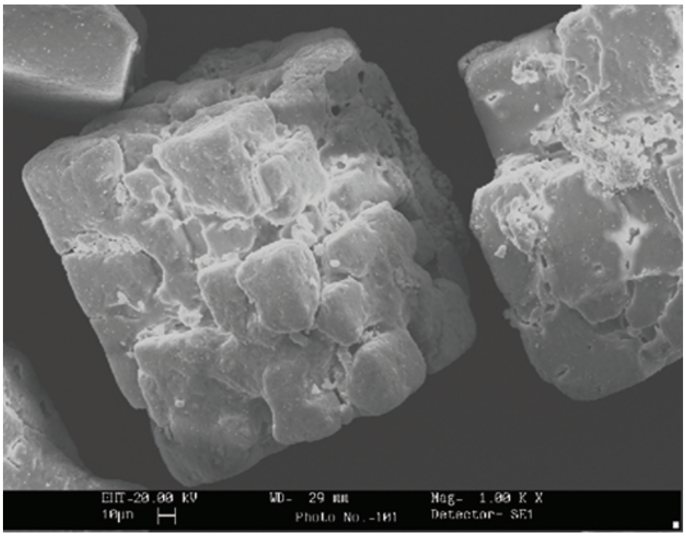

Figure 3a: Sodium chloride, microscopy image

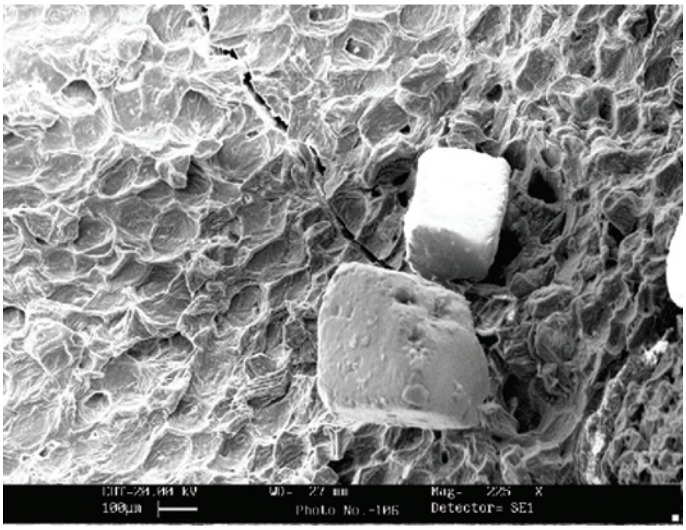

Figure 3b: Sodium chloride on a crisp, microscopy image

Consumers tend to prefer a mixture of salts, possibly due to extended release of the salt. In a study by Leatherhead Food Research, a 50/50 mixture of freeze dried amorphous sodium chloride (~7μm) and table salt (~450μm) on crushed crisps was preferred to either table salt or freeze dried amorphous sodium chloride alone (Narain *et al.*, 2006).

8. Emulsions

As outlined, the position of salt is important to understand its full implications and to prevent consumers from swallowing large proportions of the sodium chloride in food products without detection by the palate. This principle could potentially also be applied to emulsion systems; by modifying the emulsion structure creating double emulsion systems.

Simple oil-in-water (o/w) emulsion containing salt would have all the salt dissolved in the external aqueous phase, whilst a simple water-in-oil (w/o) emulsion would have all the salt dissolved in the internal aqueous phase. The sensory perception of salt from these two systems is different - in the o/w emulsion the salt is directly in contact with the palate, whilst in the w/o emulsion it is the oil that is in contact with the palate and not the aqueous phase. In the latter case the w/o emulsion inverts in the mouth to an o/w system and the salt can then be detected by the palate. However this takes some time and is influenced by the host food so the salty perception may be reduced.

A double-emulsion system could be prepared in water to create water-in-oil-in-water (w/o/w) emulsion (Figure 4). Maximum saltiness would thus be obtained when all the salt is dissolved in the external aqueous phase, which will have a higher concentration of salt in the external aqueous phase than a regular oil in water solution with the same salt content and would therefore likely be perceived more salty.

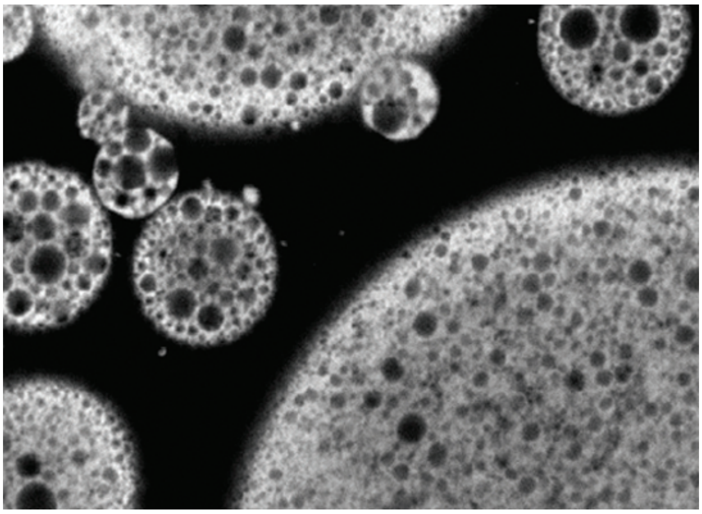

Figure 4: Water-in-oil-in-water emulsion

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