EFFECT OF HIGH-IN-TASTE PULSES ON TASTE PERCEPTION

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Abstract

There is an increased urgency, advocated by the WHO, to reduce the sodium content in food products. A significant lower sodium intake of the world population should lead to reduced incidences of high blood pressure and associated cardiovascular diseases. A number of approaches can be taken to reduce sodium: via adaptation, salt substitutes, multisensory principles and salt boosters. Other ways to enhance perception were explored as a means to reduce sodium, by building further on the generic principle of receptors as contrast detectors. The increase of saltiness perception was investigated via controlled delivery of ‘high-in-salt pulses’ into the mouth of assessors using a gustometer. A significant effect on saltiness perception for 2 second ‘high-in-salt pulses’ was shown, as compared to constant salt delivery. These results suggest that saltiness perception may be modified by changing the salt delivery profile.

Introduction

There is a growing body of scientific evidence regarding the link between high sodium intake and high blood pressure, and the associated risk with cardiovascular disease (1). Considering the significant reductions that the WHO is recommending (daily intake of 5 g of salt (NaCl) per day (2000 mg sodium), instead of current typical daily intakes of 9-12 g of salt), there is a need for solutions for sodium reduction (2). The key challenge is maintaining the same taste with lower sodium content. There are a number of approaches that can be taken to reduce sodium:

- **Adaptation.** By reducing sodium in products in small steps a preference for lower salt products can be induced (3). This approach is most successful when it is conducted across industry, to prevent that consumers will switch to high-salt alternatives.

- **Salt substitutes.** Traditionally, salt substitutes are used to replace NaCl. Composites of this group are primarily mineral salts, typically KCl, often in combination with different types of bitter maskers, in order to mask the bitter and metallic off-taste of this mineral salt (2, 4).

- **Multisensory principles.** It is well established that the different senses can influence each other (e.g. 5). Therefore, in order to enhance saltiness perception, other modalities may be modified (e.g. aroma, colour, texture). Few examples have been reported on increasing saltiness by aroma (4, 6). see also Batenburg et al., elsewhere in these proceedings.

- **Salt boosters.** The toolbox for salt reduction might be extended with new ingredients that can trigger or boost the sodium channel receptor (potentially...
enabling >30 % sodium reduction). Approaches to find such ingredients (using cellular receptor assays) are currently scoped by specialized food and ingredient companies.

What else? We have focused on other ways to enhance perception, by building further on the generic principle of receptors as contrast detectors, e.g. (7). It was investigated whether contrast in taste delivery can increase perception. More specifically, it was tested whether short high-in-taste pulses can increase taste perception as compared with constant stimulation using the same overall tastant content. We used salt solutions as a model system. With sip-wise sample delivery a minimum sample frequency rate of about 15 seconds can be reached. In order to increase the frequency rate we used a gustometer (8). The use of the gustometer as a method for delivering different concentrations in continuous flow to the mouth of the panellist has been validated by comparison with similar conditions delivered via cups (9). This paper investigates the increase of saltiness perception via controlled delivery of high-in-salt pulses, as a means to reduce the sodium content in products.

Experimental

A gustometer (8) was used under conditions that were optimized for continuous flow mode. Four different delivery designs were used (Figure 1A). Each design delivered the same average NaCl concentration of 6.3 g/L during 60 seconds. The flow rate was 40 mL/min. Design 1 consisted of a constant delivery of 6.3 g/L NaCl. In design 2 the concentration was changed every 5 seconds, with a concentration difference of 10 % (5.95 and 6.65 g/L NaCl, respectively), starting with the lower concentration. Design 3 was similar to design 2, except that the concentration difference was 20 % (5.6 and 7.0 g/L NaCl). In design 4 the lower concentration (5.6 g/L NaCl) was delivered for 8 seconds, followed by a high concentration pulse of 2 seconds (9.1 g/L NaCl) (38 % concentration difference); this was repeated six times. The total flow rate during the 2 second pulses was 48 mL/min. The change in the flow rate was not perceivable by the panel. Eleven subjects (20-47 year) were recruited for this experiment. The sensory evaluation via time intensity and data analysis (Anova of area under the curve (AUC)) are described in detail in (9).

Results

The average time-intensity profiles as produced by the panel are presented in (Figure 1B). It can be seen that the profile resulting from the constant concentration delivery reaches maximum saltiness after 15 seconds (a score of about 75), followed by a slight decrease in saltiness (around 70). The saltiness score is then relatively stable until the salt delivery is ended. Finally, a rapid decrease in perceived saltiness corresponds to the beginning of the aftertaste part.

The other 3 delivery profiles display similar features to each other. These profiles consist of 6 peaks that correspond to the varied saltiness delivery repeated every 10 seconds. The amplitude of the peaks is globally similar for each of the three delivery profiles: although the salt differences for the three profiles are different, the average salt content delivered into the mouth is the same. While the two 5 second profiles show a slight decline with time of the peak maximums and minimums, the peaks resulting from the 2 second pulses appear to increase slightly throughout their delivery.
The analysis of variance of the average area under the curves revealed a significant stimulus effect for the parameters Total taste (F= 3.29, p= 0.034), a tendency for the Taste (F= 2.82, p= 0.056), but no effect for the parameter Aftertaste (F= 2.09, p> 0.1) (Figure 2A). From the Student-Newman-Keuls tests it can be concluded that the 2 second pulse profile has been rated significantly more salty than the constant stimulus over the whole rating time (Total taste) and to a lower extent during the stimulus delivery in the mouth (= Taste parameter). The two other (5 second) profiles were not perceived as significantly different from the other designs.

All three designs with varied saltiness delivery were offered in the same sequence of ‘Low-high’ concentration. In other experiments that involved both ‘Low-high’ and ‘High-low’ sequences a significantly higher AUC was obtained for the aftertaste of the ‘Low-high’ sequence, which appeared to be directly proportional to the last concentration of the sequence (9). In order to exclude effects that are directly due to the impact on the aftertaste the same concentration can be delivered for a fixed interval at the end of each design. Furthermore, as the 2 s delivery profile had a higher flow rate than the other conditions, this condition should be tested with the same flow rate as the other designs. These adaptations have been incorporated in further experiments (9).

We have explored the implication of these findings for product design. Therefore a chicken cream soup product with high-in-salt (chicken) particulates was tested (Figure 2B). The original soup contains unsalted particulates (A and B), while the adapted soup (C) comprises high-in-salt particulates. The high-in-salt particulates deliver a contrast in saltiness during consumption of the soup, reflecting the high-in-salt pulses as delivered by the gustometer. Furthermore, during consumption the particulates are being chewed and therefore the residence time of these particulates in the mouth, and the salt released during chewing, can be expected to be higher than that of salt present in the liquid soup itself.

The impact on saltiness perception of these soups was tested with a group of 60 consumers. Consumers received two of the three chicken cream soups on two consecutive days (one soup on each day, in random order). Consumers had to...
answer various questions, including a question on the saltiness of the soup. The soup with the salty particulates (C) was scored significantly higher in saltiness than the soup with the same sodium content and unsalted particulates (B) (Figure 2B). The saltiness of Soup A was not significantly different from the two other soups. Thus using high-in-salt particulates the perceived saltiness of the soup was increased (4, 10). It can be envisaged that several parameters will affect the (enhanced) perception of such a soup with high-in-salt particulates, such as the size and number of particulates, diffusivity of salt from the particulates, and the salt differences between particulates and soup.

Figure 2. A. Areas under the curve. B. Sodium distribution in soups. Darker shading reflects higher sodium content. The saltiness of the soups as determined with consumers is indicated. Mean values associated with the same letter are not significantly different (α = 0.05).

References