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Research report

Enhancing consumer liking of low salt tomato soup over repeated exposure by herb and spice seasonings ☆

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ABSTRACT

There is strong evidence for the link between high dietary sodium and increased risk of cardiovascular disease which drives the need to reduce salt content in foods. In this study, herb and spice blends were used to enhance consumer acceptability of a low salt tomato soup (0.26% w/w). Subjects (n = 148) scored their liking of tomato soup samples over 5 consecutive days. The first and last days were pre-and post-exposure visits where all participants rated three tomato soup samples; standard, low salt and low salt with added herbs and spices. The middle 3 days were the repeated exposure phase where participants were divided into three balanced groups; consuming the standard soup, the low salt soup, or the low salt soup with added herbs and spices. Reducing salt in the tomato soup led to a significant decline in consumer acceptability, and incorporating herbs and spices did not lead to an immediate enhancement in liking. However, inclusion of herbs and spices enhanced the perception of the salty taste of the low salt soup to the same level as the standard. Repeated exposure to the herbs and spice-modified soup led to a significant increase in the overall liking and liking of flavour, texture and aftertaste of the soup, whereas no changes in liking were observed for the standard and low salt tomato soups over repeated exposure. Moreover, a positive trend in increasing the post-exposure liking of the herbs and spices soup was observed. The findings suggest that the use of herbs and spices is a useful approach to reduce salt content in foods; however, herbs and spices should be chosen carefully to complement the food as large contrasts in flavour can polarise consumer liking.

Introduction

Sodium chloride is an important component of many food products used for taste, texture and preservation. In addition to eliciting salty taste (McCaughey & Scott, 1998), sodium chloride can suppress bitterness (Frijters & Schifferstein, 1994; Keast & Breslin, 2002), increase sweetness at low concentrations (Keast & Breslin, 2003) and enhance the perception of volatile flavour compounds (Ventanas, Puolanne, & Tuorila, 2010). However, dietary salt intakes are much higher than nutritional requirements in most countries (Brown, Tzoulaki, Candeias, & Elliott, 2009). There is strong evidence for a link between high dietary sodium and hypertension; thereby increasing the risk of cardiovascular disease (Cook et al., 2007; Strazzullo, D'Elia, Kandala, & Cappuccio, 2009; Tuomilehto et al., 2001). In western populations, approximately 75–80% of dietary salt is derived from processed food (Food Standards Agency, 2009). However, decreasing salt content in processed food products is a big challenge for the food industry as it has an adverse effect on product sensory profile and, hence, consumer acceptability (Breslin & Beauchamp, 1997). Currently, there are a number of approaches in use. Stealth or small step reduction is a promising approach; however, the amount of salt that can be reduced following this approach is limited (Girgis et al., 2003). Mineral salts such as potassium chloride, calcium chloride and magnesium sulphate have been used to substitute the salty taste of sodium chloride in a number of food products (Vanderklaauw & Smith, 1995), but they have undesirable aftertastes that limit their applications in food manufacturing (Liem, Miremadi, & Keast, 2011). The sourness of acids such as citric acid can be utilised to enhance the perceived saltiness (Hellemann, 1992; Little & Brinner, 1984) as can taste enhancers such as amino acids, monosodium glutamate, lactates, and yeast products (Ball, Woodward, Beard, Shoobridge, & Ferrier, 2002; Jinap & Hajeb, 2010) and salt associated odours (Lawrence, Salles, Septier, Busch, & Thomas-Danguin, 2009; Noble, 1996).

Flavouring of foods using blends of natural herbs and spices is a preferred approach to reduce salt as it results in a clean label

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product, avoiding inclusion and declaration of chemical compounds. By careful reformulation using herbs and spices, the sensory characteristics and consumer acceptability of low salt products could be improved or maintained. However, studies in this area are limited. Mitchell, Brunton, and Wilkinson (2013) reported no significant difference in liking between a standard vegetable soup and a low salt soup with no herbs or low salt with rosemary, possibly due to the relatively small population size (n = 60). Furthermore, the standard and low salt soups contained 0.93% and 0.45% salt respectively, whereas current UK market soup products in 2013 were surveyed and found to have average salt content of 0.5%. The question, therefore, remains whether using herbs and spices is a useful tool for lowering salt content of commercial food products.

Preferences of food qualities are mostly caused by learned experience rather than genetics (Rozin & Vollmecke, 1986). Although food neophobia may cause reluctance to eat novel food (Pliner & Hobden, 1992), repeated exposure over time to the food stimulus may increase the familiarity and may alter taste perception and liking. Whilst repeated exposure to familiar foods may reduce the liking (Berlyne, 1970; Stang, 1975), novel foods are more likely to become more acceptable during the course of exposure (Birch & Marlin, 1982; Pliner, Pelchat, & Grabski, 1993; Stein, Nagai, Nakagawa, & Beauchamp, 2003). A novel stimulus causes an elevation in unfamiliarity, uncertainty or complexity of products, and hence an adverse initial effect on people who are food neophobic. The mechanism by which repeated exposure enhances the liking of novel foods can be explained as dissipation of initial food neophobia (Pliner, 1982).

In repeated exposure liking studies it is typical to make direct comparisons of two or more products at pre- and post-exposure tests but to only expose consumers to one product during the exposure period. This enables comparison of the effect of repeated exposure versus no exposure on liking ratings. Such metholodology was used by Methven, Langreney, and Prescott (2012) who hypothesised that reducing salt in a food may present a degree of novelty in an otherwise familiar food flavour which might be the cause of reduced liking and, therefore, repeated exposure may increase both familiarity and liking of the reduced salt food. In their study a carrot and coriander soup was used in which the salt content was reduced from 0.7% added salt to no added salt. This reduction led to a significantly lower liking pre-exposure. Liking of the no salt soup significantly increased over eight consecutive tasting sessions, until it was not significantly different from the standard salt soup. However, this study did not test the effect of the herbs on liking as both the standard and the low salt soup contained the coriander.

There is evidence that salt intake, salt taste sensitivity and liking of salty foods influence one another (Hayes, Sullivan, & Duffy, 2010). In their study a strong association was found between salt liking and measured sodium intake. Hence, it is perhaps important to consider dietary sodium intake in studies concerning salt liking and this was addressed in the current study.

The hypothesis of the current study was that the addition of herbs and spices can enhance the liking of low salt tomato soup. The first aim was to establish whether incorporation of herbs and spices into low salt tomato soup would give an immediate improvement in the hedonic liking. However, modifying the tomato soup's sensory profile by the reduction in salt content and addition of herbs and spices would create novelty in the flavour of tomato soup which may affect the participants' preference. The second aim was to repeatedly expose the participants to the tomato soup sample over 3 days and record the change in soup's acceptability, familiarity and consumed volume over exposure time. Finally, the third aim was to compare participant's liking of tomato soup pre- and post-repeated exposure to determine whether repeated exposure improved acceptability and familiarity of the low salt tomato soup with herbs and spices inclusion.

Materials and methods

Sample preparation

All soup samples were formulated and produced as an instant tomato soup powder by McCormick (Haddenham, UK). The aim was to set the salt (sodium chloride) content of the standard tomato soup at 0.5% (w/w) salt to represent the average salt level of UK commercial instant soup brands. Tomato soups with reduced salt levels (i.e. 30, 40, and 50% salt reduction) were produced for an initial consumer test to determine the low salt level to proceed into the main study. This was done to establish a lower salt level that the consumers liked significantly less than the standard soup level. In order to develop an herb and spice modified tomato soup that was acceptable to consumers, the formulation of the selected low salt sample was modified by inclusion of three different blends of herbs and spices as follows:

Basil modification: the low salt soup with added basil, black pepper, celery, and garlic.

Cumin and Coriander modification: the low salt soup with added cumin, coriander, ground celery seed and garlic.

Oregano modification: the low salt soup with added oregano, bay leaves, garlic, celery and black pepper.

For all tasting sessions, soup samples were prepared by suspending tomato soup powder in boiling water (11 g powder/100 mL water). The water used was potable tap water filtered through a cartridge (Brita, Bicester, UK) containing activated carbon to reduce odour and chlorine-derived compounds and ion-exchange resin beads to reduce levels of calcium carbonate. In the sip tests (i.e. sensory profiling, initial consumer trials and in the pre- and post-exposure studies), soup samples were prepared and held in a water bath at 70 °C before serving, serving temperature was 65 ± 3 °C. Each respondent received 30 mL soup in a china cup (50 mL). For the repeated exposure study (Visits 3–5), tomato soups were prepared and then held in thermos flasks for a maximum 15 min before serving, serving temperature was 69 ± 4 °C; each participant received a full portion (400 mL) of soup.

All experiments in the study were carried out in a central location using individual sensory booths. The booths were lit by artificial daylight and the temperature in the booths was controlled to 23 °C.

Selection of the low salt level samples

Four samples were tested in this experiment, the standard tomato soup (0.5% w/w salt content) and three different reduced salt samples (i.e. 30, 40 and 50% salt reduction). The consumers (n = 101) recruited to participate in this trial were students and staff at the University of Reading. Samples (30 mL) were presented monadically in a balanced order with three digit random codes and liking (overall liking followed by liking of appearance, taste and texture) was scored on a 9 point hedonic category scale (1: dislike extremely, 9: like extremely). They were asked to rinse their palates between samples with water and crackers (Carr's, UK).

Sensory profiling of the tomato soup variants

Five tomato soup variants were tested (i.e. standard, low salt, basil modification, cumin and coriander modification and oregano modification). A trained sensory panel (n = 10) developed a consensus vocabulary of 56 attributes over four tasting sessions. Scoring of all samples was carried out individually using 15 cm unstructured line scales (scaled 0–100). At each scoring session the standard sample was presented as a reference at the start of the session to re-familiarise the panel, along with the panel mean scores for the standard on a paper version of the line scales. The standard was then

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