



Cayenne pepper in a meal: Effect of oral heat on feelings of appetite, sensory specific desires and well-being



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ABSTRACT

The present study investigated appetite sensations, hedonics, sensory specific desires, physical- and psychological well-being sensations during and after intake of a meal with- and without increased oral heat induced by addition of cayenne pepper. Subjects ($n = 66$) completed a randomized cross-over study involving a tomato soup with and without added cayenne pepper (0.593 mg capsaicin). Self-reports were evaluated at 5 min intervals during intake and at 1 h intervals until four hours post intake using VAS-scales and 9-point scales. Sensory specific desires were further studied by liking and wanting of food samples representing the sensory profiles: sweet, sour, salt, bitter, fat and spicy, respectively. The soup with cayenne pepper added was perceived significantly more spicy but equally liked, and resulted in significant higher satiation at the end of the meal and one hour post intake. Further, adding cayenne pepper was associated with significantly higher sensory satisfaction during intake, and the subjects feeling significantly more energetic and overall satisfied one hour post intake. During intake of the soup with added cayenne pepper, desire for salty and spicy foods were significantly decreased and desire for sweet and fatty foods were significantly increased. The effects were partly mirrored in subjects' liking and wanting for foods with the same sensory characters. These results suggest that orally perceived heat through addition of cayenne pepper can induce changes in sensory specific desires, and that these changes can potentially influence eating behavior.

1. Introduction

Hot spices are used in many cuisines to stimulate our senses with flavors, heating and burning sensations. Apart from providing pleasure during eating, capsaicin, the predominant pungent component in chili peppers, has been shown to increase energy expenditure (Lejeune, Kovacs, & Westerterp-Plantenga, 2003; Westerterp-Plantenga, Smeets, & Lejeune, 2005).

Several studies have investigated if capsaicin also possessed appetite altering effects and found that the appetite suppressive effects of capsaicin were most evident when administered orally compared to gastrointestinal ingestion (Ludy & Mattes, 2011; Westerterp-Plantenga et al., 2005) and when provided at maximum tolerable dose (Ludy & Mattes, 2011). However, oral administration of capsaicin using maximum tolerable doses might be unrealistic for appetite management in real life, due to the strong burning sensation in mouth and stomach. Therefore, we wanted to investigate, if addition of lower doses of a hot spice to a meal may also suppress appetite during and after a meal, ensuring the meal was still palatable.

To quantify the potential appetite altering effect, appetite sensations have been studied at different time points in relation to intake; before- and after a meal (Westerterp-Plantenga et al., 2005), every hour (Janssens, Rick, & Westerterp-Plantenga, 2014), and at 30 minute intervals (Gegersen et al., 2013; Ludy & Mattes, 2011). Other studies have followed dynamics of hunger and satiating sensations during eating of a meal (Møller, 2013; Reinbach, Martinussen, & Møller, 2010). The present study aims to provide a detailed description of development in appetite related sensations during and after a meal with a tolerable amount and without addition of a hot spice.

The appetite sensations are not the only sensations affecting intake. The hedonic dimension and feelings related to well-being that develop post-ingestion and post-absorption, are among other factors believed to be important for the consumers overall product satisfaction (Andersen, 2015; Andersen & Hyldig, 2015a, 2015b; Boelsma, Brink, Stafleu, & Hendriks, 2010) and influence food choice and intake (e.g. Köster, 2009; Sørensen, Møller, Flint, Martens, & Raben, 2003). Furthermore, sensory desires developing during a meal are believed to be important for our post meal food choices and intake. Sensory

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specific desires developed during consumption of a meal are affected by the sensory characteristics of the foods eaten (Reinbach et al., 2010). These desires can potentially lead to additional calorie intake and thus contributing to a positive energy balance (Mela, 2006).

Although several studies have addressed appetite measures after intake of capsaicin, a more complete description of the feelings and sensations developing during and in the period after consumption of a meal containing capsaicin has not been conducted. A more complete description of appetite, wellness and developing desires may reveal important information on the consumer experience and intent after consumption of a food or meal.

The aim of the present study was therefore to provide a broader view on feelings and sensations related to the experiences around ingestion of a meal using hot spice as a vehicle to induce effects. The objectives were to evaluate whether oral heat through addition of tolerable dose of cayenne pepper; a) altered appetite and hedonic appreciation during consumption and up to 4 hours post intake, b) affected sensations of physical and psychological well-being up to 4 hours post intake, and c) showed transfer effects by inducing sensory specific desires.

2. Methods

2.1. Subjects

Subjects (N = 66) were recruited for the randomized, cross-over consumer study. Inclusion criteria were: age between 20 and 50 years; users of tomato soup and a general liking of hot spices; not suffering from illnesses or food allergies; willingness to taste a broad range of food samples. The characteristics of the subject group are shown in Table 1.

2.2. Matrices

2.2.1. Soups

Two iso-caloric (226 kJ/100 g) versions of tomato soup (Classic tomato soup with thyme, Karoline's Køkken, Arla Foods, Denmark) were prepared. The soup was heated slowly until 65 °C and half of the portion was added cayenne pepper in capsules. In total 450 mg cayenne pepper per L soup was added, which corresponded to 1.13 mg/L capsaicin and 40,000 Scoville heat units (Premium herbal, Nature's Way, Canada). Prior to serving, soups were kept in thermos bottles and one minute before serving, 75 g soup was portioned into a thermos mug.

2.2.2. Foods with specific sensory characters

Twelve food samples were chosen from a focus group discussion with 10 experienced sensory panel members. The foods represented the sensory characters of sweet, sour, salt, bitter, spicy and fat (Table 2) and

Table 1
Subject characteristics.

Characteristics	
N _{total} (number)	66
Gender (number of males/females)	21/45
Age (years) ^a	27.5 (20–48)
BMI (kg/m ²) ^a	22.4 (17–32.9)
Educational level ^b	3.9 (2–6)
General frequency of chili consumption ^c	2.5 (n ₁ = 3, n ₂ = 36, n ₃ = 19, n ₄ = 8)

^a Mean (min – max).

^b Mean (min – max): 1: lower secondary, 2: higher secondary, 3: higher secondary with trainee, 4: short-length higher education, 5: medium-length higher education, and 6: long higher education.

^c Refers to fresh chilies and foods added chili spice. Mean (number of subjects indicating to eat chili 1: daily, 2: weekly, 3: monthly, and 4: rarer).

Table 2

Foods used to represent specific sensory characters of sweet, sour, salt, bitter, spicy and fat.

Sweet	Sour	Salt	Bitter	Spicy	Fat
Canned peach in sucrose brine	Green rhubarb	Salted popcorn	Grape-fruit	Wasabi pea	Avocado
Dried banana	Green apple	Pretzel stick	Dark chocolate, 72%	Chili nut	Whipped cream

were tasted before and after eating the soup. For each participant, the samples were presented in the same order before and after intake, but presentation order was randomized between subjects.

2.3. Procedure

The experimental sessions lasted 5 h in total. During the first hour (12 noon until 1 o'clock p.m.) subjects were at the sensory laboratory, whereas in the following four hours they proceeded with their everyday activities. The subjects were instructed to eat breakfast and a small snack but refrain from eating 2 ½ h prior to the test. An overview of the study design is shown in Fig. 1.

When arriving to the sensory laboratory, subjects received an introduction on how to conduct the test. To study whether potential alterations in sensory specific desires were manifested as changes in affective eating behavior (*liking* and *desire to eat more*) participants consumed 12 food samples representing the six sensory characters before- and after intake of soup. The 12 samples were presented as taste samples (mean weight 3.5 g) and eaten to completion. To study dynamics of appetite sensations, hedonic appreciation and sensory specific desires during consumption, subjects ate 75 g of soup seven times (525 g in total). In addition to the soup, 500 g of water was available to each subject. Subjects were asked to finish the meal completely with no leftovers allowed. The seven portions were served to facilitate a detailed description of dynamics in appetite related sensations during the meal. In-between eating food samples and soup, approximately 12 g of yoghurt naturel was consumed to clean the palate and return to a baseline on the oral burn sensation. During the 4 h post intake subjects reported at hourly intervals their levels of physical- and psychological well-being (ref. Section 2.4) to the project staff. In case of food or beverage consumption, they were asked to report “what” and “how much”. To make sure subjects reported every hour, a reminder (SMS text message) was sent 10 minutes before each evaluation. During the four hours post soup intake subjects were allowed to have a low to moderate physical activity level (biking allowed as a max. physical activity). After the last set of measurements the subjects gave informed consent and were compensated for the participation.

Each participant completed two test meals with one meal per day and minimum of one day break between each test. A full cross-over design was employed where half of the subjects were randomly assigned to soup 1 on test day 1 and soup 2 on test day 2, and vice versa for the remaining subjects.

2.4. Questionnaires

Four different questionnaires (Q1 to Q4) were used (Table 3) in different parts of the study (ref. Fig. 1). The questionnaire related to consumption of food samples (Q1) focused on; liking and desire to eat more of the respective food samples. Pre-, post- and 1, 2, 3 and 4 h post intake of soup, questions were asked concerning; general liking of tomato soup, physical- and psychological well-being sensations and satisfaction (Q2). Satisfaction is meant to reflect a generalized appreciation of food incorporating the sensory experience and sensations

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