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Changes in aroma characteristics of simulated beef flavour by soy protein isolate assessed by descriptive sensory analysis and gas chromatography

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Abstract

Descriptive sensory analysis (DA) and gas chromatography (GC) analysis were conducted to investigate changes in aroma characteristics of simulated beef flavour (SBF) upon addition of soy protein isolate (SPI). Five attributes (beefy, roasted, yeasty, soymilk-like and cereal) were selected to assess various mixtures of SBF and SPI. The results of DA confirmed that "roasted", "beefy" and "yeasty" notes were highly positively correlated with SBF concentration, and the beefy related notes were substantially suppressed by increasing SPI content. Fifteen peaks from GC analysis were selected as indicator peaks to represent beefy attribute based on their odour-active properties assessed by GC–olfactometry and correlation of their peak areas with beefy intensity in mixtures of SPI and SBF assessed by DA. The indicator peaks may form the basis of further research to explicate the nature of SPI–SBF interactions to explain the suppression of perceived intensity of beef flavour in soy protein products.

Keywords: Simulated beef flavour; Soy protein isolate; Descriptive sensory analysis; Gas chromatography; Aroma

1. Introduction

A characteristic beef odour is one of the most important parameters to determine the quality of beef analogue products such as soy protein based meat substitutes for vegetarian and health-conscious consumers who prefer meatless products. Flavour related problems including "beany" odour (Boatright & Lei, 1999; Lei & Boatright, 2001; Wolf, 1975) and off-flavour (Inouye, Shiihara, Uno, & Takita, 2002; Maheshwari, Ooi, & Nikolov, 1995; McDaniel & Chan, 1988) have created technical obstacles to be overcome for the increased usage of soy proteins in human foods (Maheshwari et al., 1995). Aside from these undesirable yet hard-to-remove soy aromas, the interactions of soy proteins with desirable aroma components of added flavour formulations have presented a different challenge for soy based products. Gremli (1974) reported that the presence of soy protein in aqueous systems increased the retention of volatile components in samples, while Malcolmson and McDaniel (1987) observed the suppression of chicken flavour in a formulated soup at high levels of soy protein.

Considerable research has been conducted to understand the flavour-binding nature of soy proteins (Aspelund & Wilson, 1983; Beyeler & Solms, 1974; Damodaran & Kinsella, 1981a, 1981b; Li, Grün, & Fernando, 2000; O'Keefe, Resurreccion, Wilson, & Murphy, 1991; O'Keefe, Wilson, Resurreccion, & Murphy, 1991; Zhou & Cadwallader, 2004). However, most of these studies used model systems of single ingredients or specific volatile model compounds associated with flavour or off-flavour, such as a series of aldehydes, ketones, alcohols, or alkanes. Even though valuable thermodynamic information was obtained from these studies, the knowledge may not be directly

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applied to the real food system, in which the flavour ingredients usually include combinations of a broad array of subclasses of compounds. Soy proteins bind with certain desirable flavour compounds, which could have an impact on flavour suppression or alteration of flavour profiles in the mixture or final food products.

Thermally produced simulated meat flavours, so called "reaction flavours", are often employed to provide meat-like flavour in vegetarian products. Due to the complexity of the reactions involved in their creation (May, 1974), simulated meat flavours are likely to have a multifaceted aroma profile. Nevertheless, it is imperative to elucidate the influence of other ingredients such as soy protein on the sensory characteristics of the simulated meat flavours, in order to gain an understanding and provide potential strategies for overcoming the diminution in meaty aroma intensity observed in the presence of soy proteins.

Recently, we established a headspace solid phase micro-extraction (HS-SPME) technique for gas chromatographic (GC) analysis of a commercially available simulated beef flavour (SBF) ingredient (Moon & Li-Chan, 2004), and identified odour-active components by applying SPME with GC–mass spectrometry (GC–MS) and GC–olfactometry (GC–O) (Moon, Cliff, & Li-Chan, 2006). At least 70 volatile compounds were tentatively identified in the SBF by GC–MS, and 49 odour-active compounds were detected by GC–O, several of which were also detected in roasted and boiled beef samples. However, it was not possible to select any single isolated compound as being the main contributor to beefy aroma. Similarly, a review by MacLeod and Seyyedain-Ardebili (1981) described more than 450 compounds identified from cooked beef but no single character compound was reported to be uniquely responsible for cooked beef aroma. Shahidi, Rubin, and D'Souza (1986) also concluded that a particular class of compounds did not in itself result in the meat flavour and that a number of volatiles of different chemical classes existing in specific quantitative proportions were responsible for the meat flavours.

Since no single character impact compound has been identified for either authentic beef or simulated beef flavours, an alternative approach to monitor soy protein induced changes in the aroma of SBF would be to select several "indicator peaks" in the GC profiles that could be used to correlate to the perceived aroma characteristics of soy protein–SBF mixtures as assessed by sensory panelists. Indicator peaks have been applied in various ways in other food systems (Blanch, Mar-Caja, León, & Herraiz, 2000; Chiesa, Radice, Belloli, Renon, & Biondi, 1999; Kasahara, 2004). Indicator peaks could be used as a multiple-compound quality index, such as the application of several selected bacterial metabolites identified by GC–MS and GC–O to predict spoilage off-flavours in packed or smoked salmon (Jørgensen, Huss, & Dalgaard, 2001), or a group of volatile compounds selected as a "forcing index" that appeared or increased in the early stage of beer ageing, compared to several Strecker aldehydes and furfural chosen as an "ageing index" that increased mainly later in ageing of beer (Narziß, Miedaner, & Lustig, 1999).

Therefore, the specific objectives of this study were to (a) apply descriptive sensory analysis (DA) to describe the aroma attributes of SBF and soy protein isolate (SPI), (b) monitor changes in these sensory attributes as a function of different ratios of SBF and SPI, (c) elucidate the relationship between the sensory response and GC data for various mixtures of SBF and SPI, and (d) select GC indicator peaks that are correlated to beefy characteristics. The investigation of changes in aroma profile of SBF upon addition of SPI and selection of indicator peaks could lead to future applications of this methodology to evaluate factors or ingredients influencing the retention or release of beef flavour in products containing soy protein.

2. Materials and methods

2.1. Materials

The simulated beef flavour (SBF) used in this study and the previous studies (Moon & Li-Chan, 2004; Moon et al., 2006) was a commercially-available blended flavour (vegetarian beef type flavour F96×49 from Mastertaste in Arlington Heights, IL), containing maltodextrin, autolyzed yeast extract, natural flavours, onion powder and silicon dioxide. The soy protein isolate (SPI, lot #02060631-532) was a commercially available product from the Solae Company (St. Louis, MO). Protein content of the SPI analyzed by the nitrogen combustion method using a LECO FP-428 (LECO Corporation, Joseph, MI) was $89.3 \pm 0.1\%$ using 6.25 as a conversion factor (Puppo et al., 2004; Renkema & van Vliet, 2002). The solid phase assembly holder, 50/30 μm stableflex divinylbenzene/carboxen/polydimethylsiloxane (DVB/CAR/PDMS), 15 mL capacity GC sample vials and polypropylene hole cap with PTFE/silicone septa were purchased from Supelco (Sigma–Aldrich Canada, Oakville, ON).

2.2. Sensory analysis

Descriptive sensory analysis was conducted by adapting the method of Zook and Pearce (1988) to obtain data describing the sensory attributes of SBF and SPI.

2.2.1. Panelist training

Ten subjects consisting of 8 women and 2 men with an interest in descriptive sensory evaluation were selected from students in the Food Science graduate program at the University of British Columbia and from food development staff at a food company producing soy-based meat alternative products for vegetarians and consumers preferring meatless products. The panelists received 8 h of training, consisting of four 2-h sessions conducted over 2 weeks.

2.2.1.1. Training session I. The objectives of the first training session were to discuss the aroma characteristics of the