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The influence of a high-fat meal on fat taste thresholds

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ABSTRACT

A high-fat diet for four weeks has been shown to attenuate fat taste sensitivity in healthy weight individuals. However, there is minimal evidence as to whether a single high-fat meal immediately prior to fat taste threshold testing has an effect on thresholds. Therefore, the aim of the study was to determine the effect of a high-fat meal immediately prior to detection threshold testing for oleic acid (C18:1). Thirty-two participants (15 males, 17 females, aged 39.1 ± 3.1 years, Body Mass Index 23.1 ± 0.7 kg/m^2) attended three laboratory sessions. In each session, participants were randomly assigned to one of three different types of breakfast: a high-fat (60% energy from fat), or low-fat (20% energy from fat) or macronutrient balanced (33% energy from fat) frittata. Fat taste thresholds were evaluated using ascending forced choice triangle tests on two occasions each day; once one-hour post breakfast and then one-hour post the completion of the first threshold test. There was no effect of breakfast type on fat taste detection thresholds for the first testing session of each day ($P = 0.288$), or the second testing session of each day ($P = 0.754$). There was also no effect of breakfast within each day (day 1: $P = 0.198$, day 2: $P = 0.199$, day 3: $P = 0.125$). There was no effect of macronutrient composition on the ability of participants to rank the level of fat in food ($P = 0.345$), or preference for the level of fat in food ($P = 0.187$ –0.868). This study provides preliminary evidence that the composition of the meal consumed by a participant immediately prior to testing does not affect fat taste thresholds.

1. Introduction

Emerging evidence from humans and animals suggests a taste modality responsive to fat (Keast & Constanzo, 2015; Running, Mattes, & Tucker, 2013). Mounting evidence is suggestive of a link between dietary fat consumption and sensitivity to fatty acids. Research has focussed on the potential association between excess dietary fat consumption and sensitivity to fatty acids throughout the alimentary canal (Little & Feinle-Bisset, 2011; Stewart et al., 2011). This work also suggested that oral fatty acid sensitivity is linked to body mass index (BMI) with hypersensitive individuals having lower BMIs than hyposensitive individuals. Nevertheless, this association remains contentious with some other studies finding no association between BMI and oral fatty acid sensitivity (Kamphuis, Saris, & Westerterp-Plantenga, 2003; Mattes, 2009, 2011; Stewart & Keast, 2012).

Adaptation of the taste system has been shown to occur with some nutrients including sodium chloride (NaCl) where increasing the amount of dietary sodium increases the taste detection threshold of NaCl (Mattes, 1997). Similarly, fat taste thresholds may be influenced by long-term fat consumption with modulation occurring after consumption of a modified diet over a 4-week period (Newman, Bolhuis, Torres, & Keast, 2016; Stewart & Keast, 2012); however, there is little evidence surrounding the fat content of a meal immediately prior to testing being a contributing factor to intra-individual variation in fat taste detection thresholds (Tucker, Nuessle, Garneau, Smutzer, & Mattes, 2015).

There have been numerous studies investigating the influence of meal consumption on primary taste thresholds, but results are variable with some studies showing an effect (Moore, Linker, & Purcell, 1965; Suchecka, Klimacka-Nawrot, Galazka, Hartman, & Blonska-Fajfrowska, 2011; Zverev, 2004), while others showing no effect (Pasquet, Monneuse, Simmen, Marez, & Hladik, 2006). Pasquet et al. (Pasquet et al., 2006) investigated the effect of a test meal on detection and recognition thresholds for the primary tastes and found no differences in taste thresholds for sucrose, fructose,

Abbreviations: BMI, body mass index; C18:1, oleic acid; NaCl, sodium chloride; PROP, 6-*n*-propylthiouracil; HF, high-fat; RF, regular-fat; LF, low-fat; ICC, intra-class correlation.

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sodium chloride (NaCl), 6-*n*-propylthiouracil (PROP) and quinine pre- and post-meal. However, Moore et al. (Moore et al., 1965) reported that there was a trend for a reduced taste of sucrose after a meal (the macronutrient composition of the meal was not discussed). Similarly, another study reported that consumption of a high-carbohydrate meal influences taste perception of sweet taste in men, but not women (Suchecka et al., 2011). The same study also reported that salty taste was not influenced by the high-carbohydrate meal (Suchecka et al., 2011), suggesting that it may be a macronutrient specific effect. The composition of the meals provided to the participants in these studies may impact on the differing results found for example, a meal high in sodium may directly increase or decrease sodium thresholds, however a meal high in sucrose may have no effect on sodium thresholds. In addition, Tucker et al. (Tucker et al., 2015) investigated this concept with regards to fat taste and reported a negative correlation between the total amount of fat and monounsaturated fat consumed in a meal prior to testing and taste intensity ratings for linoleic acid. Thus, these findings suggest there is a possible association between dietary fat and fat taste thresholds which warrants further investigation. Therefore, this study aimed to determine the effect of a high-fat (60% fat: 20% carbohydrate: 20% protein), low-fat (20% fat: 40% carbohydrate: 40% protein) or macronutrient balanced (33.3% fat: 33.3% carbohydrate: 33.3% protein) meal on fat taste thresholds.

2. Experimental methods

2.1. Participants

Power analysis was conducted prior to the study to determine an appropriate sample size to achieve adequate statistical power. Data were used from a prior study which evaluated detection thresholds for fatty acids (Stewart et al., 2010). Using an α level of 0.05 and a 10% β (90% power), it was predicted that 31 participants would be required for this study to detect a C18:1 detection threshold difference of 0.65 mM. Participants were recruited from Deakin University, Burwood, Victoria, Australia and the surrounding suburbs. Participants were required to be non-smokers and aged between 18 and 75 years. This study was approved by the Deakin University Human Ethics Advisory Group (HEAG-H20_2012), and all participants provided informed, written consent prior to participating in the study.

2.2. Study outline

This study was a randomised crossover study where participants were exposed to all treatments. Participants were required to attend three laboratory sessions at least one day apart at the Deakin University sensory laboratory with the maximum time between sessions being 3 days. There was no strict time in which the sessions had to be completed, however the maximum time taken to complete all sessions was 2 weeks. In each session, participants attended the laboratory at the same time (0900hr) where they consumed one of the three breakfasts; a high-fat, low-fat or equal fat, protein and carbohydrate breakfast, which had to be consumed within a 30 min period. After a one hour break, they were tested for their oral sensitivity to C18:1 in duplicate (Fig. 1). Participants were required to complete a 24-h food record at baseline.

2.3. C18:1 samples

Food grade C18:1 was added to long-life skim milk samples at varying concentrations (0.02, 0.06, 1, 1.4, 2, 2.8, 3.8, 5, 6.4, 8, 9.8, 12 mM), as per previous research (Haryono, Sprajcer, & Keast, 2014).

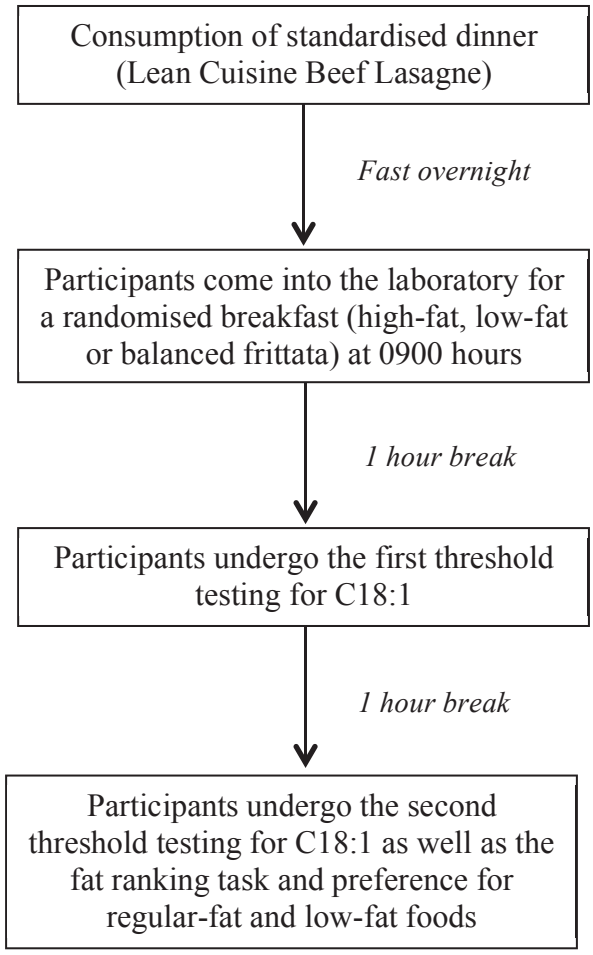

Fig. 1. Overview of the study design.

2.4. Detection thresholds for C18:1

Fat taste thresholds to C18:1 was determined using triangle tests with ascending forced choice methodology. Participants were presented with three samples on a tray; two were control samples and the other containing a set concentration of C18:1. Fatty acid samples were presented in ascending order from the lowest concentration (0.02 mM) to the highest (20 mM) (Haryono et al., 2014). The participants were presented with samples in ascending order until they were able to identify the odd sample three consecutive times. The concentration at which they correctly identified the odd sample was reported as the participant's detection threshold for C18:1. Participants were instructed to taste the samples then spit them out, and they could take as long as they wanted to taste the samples and identify the odd sample. The average time taken was approximately 1–4 min per tray. Participants were instructed to rinse their mouths after each tray. The time between trays was approximately 1–2 min (enough time for the researcher to record whether the sample the participant chose was correct and pour the next three samples). They were also required to wear a nose clip at all times and perform the test under red lighting to minimise potential confounders from non-sensory inputs. Participants were asked to refrain from eating or drinking anything one hour prior to testing (water was allowed). Detection thresholds were measured in duplicate whereby participants were tested one hour after breakfast and then one hour after completion of the first threshold test (Haryono et al., 2014).