

Short communication

Sensory testing of recipes masking peanut or hazelnut for double-blind placebo-controlled food challenges

Background: In a double-blind placebo-controlled food challenge (DBPCFC), it is necessary that recipes comprising the allergen cannot be distinguished from placebo.

Aims of the study: We investigated whether the method of paired comparisons, a sensory difference test, could be used to test the suitability of recipes for a DBPCFC.

Methods: We used two recipes, each with three concentrations of peanut or hazelnut flour. The recipe for peanut consisted of mashed potatoes with 2.7, 8.9, or 26.8 mg of peanut flour, and the recipe for hazelnut of oatmeal porridge with 74, 247, or 742 mg of hazelnut flour. Corresponding amounts of protein in the provided 15 g portions of each recipe were 0.7, 2.3, and 6.8 mg for peanut, and 11.6, 39, and 117 mg for hazelnut, respectively. Recipes were offered together with a placebo, and evaluated on sensory features by 81 healthy volunteers.

Results: The sensory test was easy to perform. Volunteers were not able to detect peanut flour in mashed potatoes, but they recognized hazelnut flour in oatmeal porridge on visual features.

Conclusions: Sensory testing by means of the method of paired comparisons is a useful method to evaluate masking of foods for DBPCFC.

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A double-blind placebo-controlled food challenge (DBPCFC) is the golden standard for the diagnosis of food hypersensitivity (1, 2). However, it is difficult to devise good recipes for masked foods. Also, formal proof of complete masking is often not performed (3, 4). Masking may be checked by comparing foods with an allergen to a placebo in a well-controlled sensory test. Various sensory tests, commonly used in food industry or market research, are available to investigate differences between foods; for example the method of paired comparisons, the triangle test, and the duo-trio test (5). In the method of paired comparisons, the subjects receive simultaneously two samples, and indicate whether they perceive the samples to be the same or different. We preferred this test to the triangle or the duo-trio test because of its feasibility (5).

In this study, we tested two recipes, containing either peanut flour or hazelnut flour in three different doses, to investigate whether the method of paired comparisons is suitable for evaluating recipes on complete blinding with their placebos.

Methods

Volunteers

Eighty-one volunteers, 26 men and 55 women ≥ 18 years, who were not allergic to peanut and hazelnut, were allowed to participate. Most of them were students or staff members of the University.

Their mean age ($\pm$ SD) was 23.6 ($\pm$ 7.0) years. All volunteers gave written informed consent. The Medical Ethical Committee of Wageningen University approved the protocol of the study.

Design

The Department of Pharmacy of the University Medical Center Utrecht provided the test meals with peanut or hazelnut and placebos in portions for six persons in dry form. They randomized the test meals of each allergen for the different doses, and for the meals with and without allergen. The sensory tests were performed in sessions of one to six volunteers, on 7 days in a 3-week period. For testing, a sensory room with six cabins was available. A test meal with peanut or hazelnut flour was offered double-blinded with its placebo. During the test, volunteers wore noseclips to reduce the possible influence of smell.

The volunteers started comparing three test meals of mashed potatoes, each with a different dose of peanut flour, with placebo. They were asked to identify the meals comprising peanut, and to motivate their choice. The volunteers could give more than one motivation (see Table 1). Between two sets of samples, they were asked to drink water to neutralize the taste. Subsequently, they compared three test meals of oatmeal porridge with different doses of hazelnut flour in the same way.

Recipes

The test meals were based on two recipes each hiding three different doses of peanut or hazelnut flour (see Table 2). They were prepared

Table 1. Number of subjects that provided a certain motivation for correctly or wrongly identifying the food containing the allergen

Protein (mg)	Peanut						Hazelnut					
	0.7		2.3		6.8		11.6		39.0		117	
	Correct	Wrong	Correct	Wrong	Correct	Wrong	Correct	Wrong	Correct	Wrong	Correct	Wrong
Tasted	11	13	9	5	8	11	17	7	15	3	18	6
Colour	3	1	1	1	2	0	18	2	24	2	30	1
Guess	11	18	21	22	17	17	12	10	6	9	2	5
Cuticles*	—	—	—	—	—	—	9	0	15	0	12	1
Other	11	13	16	6	14	12	3	3	4	3	4	2
Total	36	45	47	34	41	40	59	22	64	17	66	15

* This category was only used for the hazelnut test meals.

Table 2. Composition of the six test meals and the two placebos

Type of allergen (amounts of protein in mg)	Peanut (0.7)	Peanut (2.3)	Peanut (6.8)	Placebo (0)	Hazelnut (11.6)	Hazelnut (39.0)	Hazelnut (117)	Placebo (0)
Amount of flour (mg)	2.7	8.9	26.8	0	74	247	742	0
Weight including mixture (g)			2.5*				5.8†	
Water (g)			12.5				9.2	
Total weight per portion (g)			15.0				15.0	

* Mixture contained: 97.7 volume% instant mashed potatoes and 2.3 volume% salt.

† Mixture contained: 66.4 volume% oatmeal flakes, 33.3 volume% brown sugar, and 0.3 volume% salt.

with the same proportions of ingredients as in recipes developed in the hospital for DBPCFC (6, 7). The amounts of flour in our recipes were 2.7, 8.9, and 26.8 mg, and those of hazelnut flour were 74, 247, and 742 mg, respectively. The protein content of the peanut flour used was 25.5%, and of the hazelnut flour 15.8%. Thus, the protein content of each test meal of 15 g in our study was 0.7, 2.3, or 6.8 mg for peanut, and 11.6, 39, or 117 mg for hazelnut, respectively. The placebo meals were exactly the same as the six test meals but without peanut or hazelnut flour.

The peanuts were partially defatted, making it easier to grind them to flour. We tested higher doses of hazelnut protein because threshold levels of hazelnut allergy are higher than of peanut (6). We used oatmeal porridge in stead of mashed potatoes to mask the brown cuticles and the more coarsely structure of the hazelnuts.

Boiled water of an average temperature of 90.5°C was added to the mashed potatoes and of a temperature between 45°C and 50°C (average 48.4°C) to the oatmeal porridge. For the porridge, a lower temperature was used, because heating of hazelnuts appeared to reduce the IgE-binding capacity of some hazelnut-allergens (8, 9). After adding water, the mashed potatoes and oatmeal porridge were divided into six portions of 15 g each.

Statistics

To investigate whether peanuts and hazelnuts could be detected in the recipes, the fraction of correct answers was calculated. Under the null-hypothesis that no difference in smell or taste could be detected between the two samples, the probability of identifying the test meal comprising protein is 0.5. A 90% confidence interval (CI) for the unknown probability was calculated from the sample fraction.

Results

Method of paired comparisons

The paired-comparison test appeared to be feasible to test recipes for DBPCFC. It took on average 30 min to perform a complete sensory session with six volunteers. The total amount of test meals, provided to one volunteer, was 180 g, which was acceptable to consume and sufficient to evaluate the test meals adequately.

Tested recipes: fraction of correct answers

The volunteers could not discriminate between foods with peanut and their placebos. For none of the three doses the fractions of correct answers differed significantly from 0.5 (Fig. 1). The fractions were 0.44 (90% CI 0.35; 0.54) for the 2.7 mg, 0.57 (90% CI 0.48; 0.66) for the 8.9 mg, and 0.48 (90% CI 0.39; 0.57) for the 26.8 mg doses of peanut flour. However, volunteers could clearly discriminate between the foods with hazelnut and their placebos. The fractions of correct answers were 0.73 (90% CI 0.65; 0.81) for the 74 mg, 0.79 (90% CI 0.72; 0.86) for the 247 mg, and 0.81 (90% CI 0.74; 0.89) for the 742 mg doses of hazelnut flour.

Tested recipes: motivation

The differences found in fractions of correct answers between the two recipes were supported by the provided

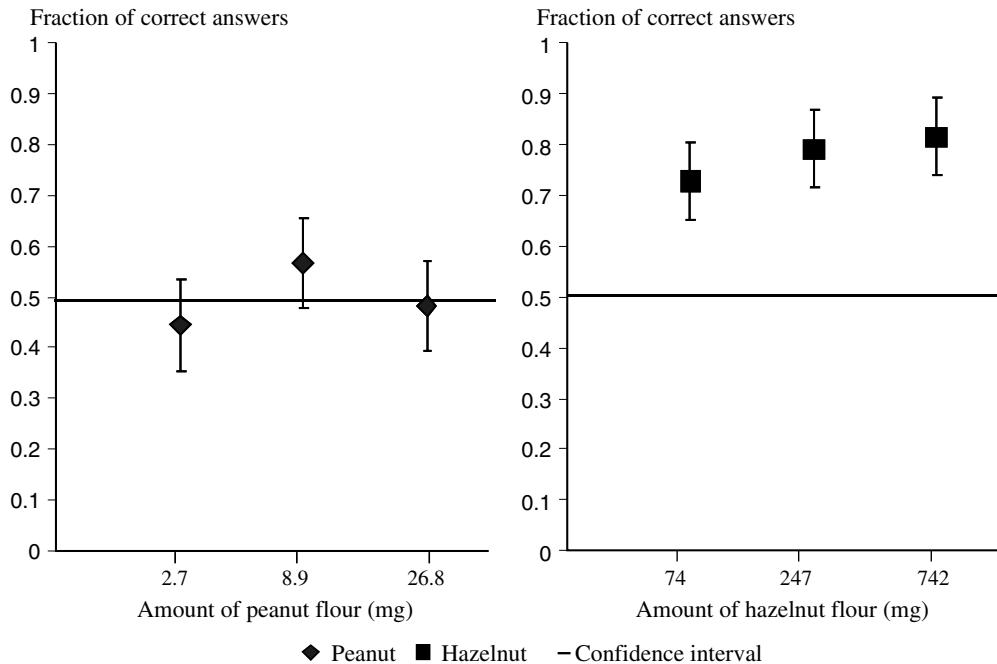


Figure 1. Fractions of correct answers for three doses of peanut flour concealed in mashed potatoes, and three doses of hazelnut flour concealed in oatmeal porridge, as given by 81 subjects.

motivations. Those for the foods with peanut were ambiguous, whereas those of hazelnut pointed more into specific directions (see Table 1).

For all three doses of peanut flour, 'Guessing' was the most frequently provided motivation. Other motivations, except colour, were also often recorded.

For the foods with hazelnut, volunteers often mentioned spontaneously that they had observed cuticles in the oatmeal porridge. Therefore, a new category 'cuticles' was included during statistical analysis to preserve the value of the test. All volunteers, except one, who gave the sight of cuticles as a motivation ($n = 37$) correctly identified the food with hazelnut. Besides cuticles the motivation colour mostly determined the choice for the correct answer. The motivations 'tasted' and 'guessed' were not predictive in correctly identifying the protein-containing food.

Discussion

Until now, little attention has been paid on sensory testing of DBPCFC recipes. We found that the paired-comparison test was suitable to test recipes for DBPCFC on sensory features. Moreover, differences in suitability of recipes for use in a DBPCFC could clearly be revealed, which was shown by the different results for peanut and hazelnut recipes. To ensure complete masking all recipes should be tested before using them in a food challenge. For each allergen one or two recipes could be developed,

tested once thoroughly on sensory features, and then be used for all double blind food challenges. Thus, the test as described in this study could contribute to standardization of DBPCFC.

In our study, we preferred the paired-comparison test to the duo-trio and the triangle test, because it is a very sensitive method (5), and it provided the opportunity to test the foods on specific sensory features. Moreover, the total amount of foods needed was less than for the other two methods. The test procedure could be made even more efficient by performing the test in two steps. First, the test could be performed in a smaller number of subjects than in our study. Then, if the recipes seem to be suitable for DBPCFC, the test could be repeated with more subjects. Once tested thoroughly, recipes might be used by many clinicians.

The sensory test differed on two conditions from those during a DBPCFC in hospital. These were the time intervals between administration of the foods, and the quantity of foods provided. The sensory test only took 30 min. In this time span six test meals and placebos were offered together, which enabled comparison of the two samples. The DBPCFC takes a day, using intervals of 30 min between each of the samples. Thus, in DBPCFC it will be more difficult to identify the food with the allergen than in the sensory test. In the short span of time of the sensory test we could not give the same quantity of foods as in a DBPCFC. However, this probably did not influence testing, because we used the same concentrations of peanut and hazelnut flour as in the hospital.

We conclude that the method of paired comparisons is suitable to evaluate masking of foods for DBPCFC. According to this test, the recipe with peanut flour in mashed potatoes appeared to be suitable for DBPCFC, but that with hazelnut flour still had some shortcomings.

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