



Peanut cross-contamination in randomly selected baked goods



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ABSTRACT

Background: The current standard of care for managing peanut allergy includes avoidance of peanut and use of injectable epinephrine; however, strict avoidance is difficult and accidental ingestion is common with potentially serious consequences. Despite vigilance and efforts to minimize the risk of accidental exposure, peanut protein cross-contamination continues to occur in a variety of foods, including baked goods.

Objective: To assess and quantify the presence of peanut protein contamination in certain baked goods.

Methods: Randomly selected baked goods were collected from bakeries in the New York and Miami metropolitan areas that sold a variety of ethnic cuisines. A second set of samples from the same bakeries was collected at least 1 week after to evaluate between-batch variability. Samples were sent to the Food Allergy Research and Resource Program to analyze peanut contamination by enzyme-linked immunosorbent assay. Consumption estimates were based on 2003 to 2010 National Health and Nutrition Examination Survey survey data.

Results: Of 154 samples from 18 bakeries, 4 (2.6%) had detectable peanut contamination with peanut protein levels ranging from 0.1 mg/100 g to 650 mg/100 g. Consumption estimates for single occasion ingestion of a contaminated item ranged from 0.07 mg to 832 mg of peanut protein.

Conclusion: In this study, unintended peanut protein was present in a small, but not insignificant, proportion of baked goods, with the potential to trigger a reaction in individuals with peanut allergy. Some products contained high levels of unintended peanut protein. The current data support the potential for accidental exposure to peanut protein with its associated risk.

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Introduction

Peanut allergy affects approximately 2% of children and is a life-long issue in approximately 80% of individuals.^{1,2} Currently, the standard of care for managing peanut allergy is based on strict avoidance of peanut and the use of injectable epinephrine in the event of a reaction.^{3–7} Despite the 2020 US Food and Drug Administration approval of an oral immunotherapy product for the treatment of peanut allergy, available through a restricted program, peanut avoidance remains an essential part of management.⁸ Strict avoidance, however, is difficult to achieve, as evidenced by the frequency of accidental exposure reactions. In a recent report, for example, 41% of children experienced a total of 68 accidental reactions to peanut within 3 years of diagnosis.⁹ In a Canadian cohort of children with peanut allergy, the annual incidence rate of reactions after accidental exposure to peanut was 12.4%, with 61.4% of reactions being moderate to severe.¹⁰

Even small amounts of peanut protein can cause severe and potentially life-threatening reactions in patients with peanut allergy.¹¹ Most of those with peanut allergy react to approximately 300 mg of peanut protein or less, with some patients reacting to less than 1 mg of peanut protein.¹¹ Efforts to minimize the risk of accidental exposure include mandatory allergen labeling for intended allergen presence in packaged foods and voluntary precautionary allergen labeling (PAL) for potential contamination during production.^{11,12} Nevertheless, varying amounts of unintended peanut protein may be present in packaged foods, regardless of labeling, posing a risk for triggering an allergic reaction.^{12,13} Although data are available for the average amounts of peanut protein found in “contaminated” packaged food products in which peanut was not an intended ingredient (with and without precautionary allergen labeling), accidental exposures occur with many other types of nonpackaged food products in which the risks are not as well characterized. One study investigated probability of peanut-induced allergic reactions in a restaurant kitchen setting, revealing cleaning of kitchen utensils is of key importance to reduce risk.¹⁴ Thus, it is crucial to have a better understanding of the level of possible peanut contamination in nonpackaged products, including baked goods, chocolate, and other snacks.¹³

This exploratory study was conducted to assess the presence and degree of peanut protein cross-contamination in randomly selected baked goods in the New York City (NYC) and Miami metropolitan areas and to evaluate the variation in the level of contamination between products within and between bakeries.

Methods

Sample Selection

Bakeries selling peanut-containing products in the NYC and Miami metropolitan areas were randomly selected from a comprehensive list of bakeries in each area. These included grocery stores and local shops that sold a mix of American, French, Cuban, Haitian, Chinese, Polish, Italian, and Indian cuisines. To assess the presence of true cross-contamination within a bakery using peanuts, bakeries that did not sell any products that intentionally contained peanuts were excluded from the analysis. Selected baked goods that did not contain intentional peanut were as follows: chocolate, carrot, raisin, and vanilla cakes and cupcakes; chocolate chip, butter, coconut, and sugar cookies; blueberry, cornbread, and cheese muffins; and cinnamon buns. At least 1 week after initial sample collection, repeat samples of the same items from the same bakeries were collected for between-batch comparison analyses. The minimum 1-week interval was selected to ensure analysis from different batches of product.

Sample Processing and Analysis

Samples of at least 100 g were purchased and packaged according to usual practice at each bakery. Samples were taken to a central, clean, peanut-free environment, then individually double-packed, weighed, labeled, cataloged, and shipped overnight to the Food Allergy Research and Resource Program (FARRP), University of Nebraska in Lincoln, Nebraska in the United States. FARRP-recommended sample handling precautions were followed to prevent cross-contamination between samples. FARRP performed qualitative and quantitative analyses for peanut protein contamination in each sample using enzyme-linked immunosorbent assay (Neogen Veratox for peanut allergen test kit). The lower and upper limits of quantification for this assay are 2.5 to 25 parts per million (ppm).¹⁵ Half of the sample was homogenized and 5 g of the homogenate was extracted for analysis, as described earlier.¹⁶ The other half of the sample was stored as back-up. The FARRP laboratory was blinded to the samples' source and whether it was part of the first or second batch from the same source.

The likely amount of peanut protein consumption for each item in which contamination was detected was estimated. Consumption was modeled on the basis of available data from the 2003 to 2010 National Health and Nutrition Examination Survey single-eating occasion consumption estimates for a variety of packaged baked goods in the category doughnuts and snack cakes.¹² For this analysis, consumption estimates were based on an average consumption amount of 73 g and the 90th percentile amount of 128 g.¹² The analysis assumed an average of approximately 25% peanut protein relative to peanut weight.^{12,17} All results are summarized and presented descriptively.

Results

Samples

A total of 155 samples were collected and sent to FARRP for analysis from 18 bakeries, with 56 samples from NYC and 99 from the Miami Metro area. Of the 154 samples tested (FARRP discarded 1 sample owing to mold), 77 were cupcakes, 48 were cookies, and 29 were muffins. Of all samples, 4 (2.6%) tested positive for peanut protein (Table 1) and all were from NYC bakeries (7.3% of the NYC samples). In the first round of sample testing, 3 samples (chocolate cookie, chocolate cake, vanilla cake) tested positive for peanut protein. Repeat testing of these same 3 products from the second batch resulted in 1 positive sample (chocolate cake) and 2 negative samples (chocolate cookie and vanilla cake).

Peanut Protein Contamination and Consumption

The peanut protein contamination levels detected in the 4 samples ranged from 1 ppm to 6500 ppm, which equates to 0.1 mg to 650 mg of peanut protein per 100 g of sample (Table 1). Based on average consumption estimates of 73 g for the US population from the 2003 to 2010 National Health and Nutrition Examination Survey for selected packaged baked goods (ie, doughnuts and snack cakes), contamination levels detected in this study equate to an estimated 0.07 mg to 474.5 mg of peanut protein consumption per single eating episode. On the basis of the 90th percentile consumption estimates (128 g), contamination levels equated to a range from 0.51 mg to 832 mg of peanut protein consumption per single eating episode.

Discussion

The results of this current study revealed the presence of unintended peanut protein in a small (approximately 1 in 40) but not insignificant proportion of baked goods, such as chocolate cake,

Table 1

Levels of Peanut Protein Contamination in Positive Samples and Estimated Amounts of Peanut Protein Consumption in Contaminated Products

Sample description	Bakery	Sample	Peanut protein, ppm (sample weight, g)	Peanut protein present, considering the average consumption amount ^a (73 g)	Peanut protein present, considering the 90th percentile consumption amount (128 g)
Chocolate cookie	5	1	4 ppm (156 g)	0.29 mg	0.51 mg
		2	BLQ	BLQ	BLQ
Chocolate cake	8	1	1 ppm (206 g)	0.07 mg	0.13 mg
		2	1.8 ppm (196 g)	0.13 mg	0.23 mg
Vanilla cake	8	1	6500 ppm (215 g)	474.5 mg	832 mg
		2	BLQ	BLQ	BLQ

BLQ, below level of quantifications (the lower limit of quantification for the Neogen Veratox Quantitative Peanut Test is 2.5 ppm total peanut, corresponding to 0.63–0.75 ppm peanut protein based on a protein content in peanut of 25%–30%); NHANES, National Health and Nutrition Examination Survey.

NOTE. 1 ppm = 1 mg of peanut per kilogram of sample product.

^aConsumption estimates (g) for the average amount and for 90th percentile amount for doughnuts/snack cakes on single eating occasion were based on national averages from the NHANES survey.

chocolate cookies, and vanilla cake. A similar frequency of peanut in packaged food with PAL was reported by others (range: approximately 1 in 100 to 1 in 10) for the United States,^{18,19} Australia,²⁰ and Canada.²¹ The amount of peanut protein we found ranged from 0.1 mg to 650 mg of peanut protein per 100 g of sample. Clinically, the amount of peanut consumption and the relevance of these contamination concentrations depend on the distribution of the contamination in the product. To provide context for the 650 mg peanut protein per 100 g of product, a single peanut kernel is composed of approximately 25% to 30% protein, which equates to approximately 250 to 300 mg of peanut protein for a large peanut most often used for snack peanuts.^{12,17,22–24} The product with the highest amount of unintended peanut protein (vanilla cake) had no detectable peanut in the subsequent batch, which speaks to the potential interbatch variability in baked goods. This inconsistency and variability may give individuals with food allergy a false sense of security and lead to an unexpected reaction to a previously tolerated product. These results indicate that, although infrequent, rather high levels of unintended peanut protein can be found in selected baked good products, similar to what has been described for packaged foods.^{16,18} Given the relatively wide ranges of peanut protein levels that can elicit a reaction in individuals with peanut allergy,^{11,25,26} the rate and varying levels of peanut protein contamination in baked goods reported herein reveal a potential risk to individuals with peanut allergy purchasing and consuming bakery goods that they would believe to be free from peanut.

It has long been recognized that the threshold dose of peanut protein to trigger an allergic reaction (also known as an eliciting dose [ED]) varies significantly between individuals with peanut allergy.^{27,28} The ED for an individual may also vary over time, and thresholds can be influenced by cofactors, such as intercurrent illness, sleep deprivation, and exercise.^{26,29,30} Previous studies in subjects with peanut allergy have revealed that 50% of these individuals have EDs ranging from 30 mg to 100 mg, and 1% may have EDs as low as 0.2 mg.^{31–33} On this basis, the results of this current analysis reveal that the amounts of peanut protein found in contaminated foods (up to 650 mg per 100 g of sample and an estimated 0.07 mg to 474.5 mg of peanut protein consumption per single eating occasion) can fall within the range of peanut protein levels that can trigger an allergic reaction in most individuals with peanut allergy.

The findings of this study regarding the rate of peanut contamination in baked goods are also consistent with other cross-contamination studies of peanut and other common food allergens.³⁴ It is important to note that other types of foods, whether fresh or pre-packaged, may contain different peanut protein levels, which may occur at higher or lower rates than those that we report herein. More comprehensive estimates of potential contamination across a wider variety of food items, larger geographic areas, and broader commercial sources (airplanes, school cafeterias, etc.) are needed

to fully understand the magnitude of the risk to the allergic consumer.

Although the present study is limited by the circumscribed geographic distribution of stores that were included, the relatively small number of samples, and the narrow range of product types tested, the results confirm that accidental exposure to peanut protein remains a risk for individuals with peanut allergy. We also intentionally chose bakeries where peanut was used in the production of other products being sold but did not evaluate stores where limited or no peanut use was reported; this represents an area for future research. Despite efforts to minimize the risk of accidental exposure, such as food labeling, peanut protein cross-contamination continues to occur in a variety of foods. Unlike mandatory food labeling, which warns of the presence of peanut, PAL is voluntary and generally states that a specific item may contain peanuts or traces of peanut protein. PAL is not always applied consistently throughout the food industry or across countries, and consumer and health care professional behavior in response to PAL varies.^{13,26,29} Both foods with and without PAL can contain peanut protein residue, contributing to consumer confusion and risk.^{35,36} Despite relatively low and infrequent contamination levels, patients with peanut allergy and their families continue to face uncertainty on dietary choices, may have associated anxiety, and may experience negative effects on quality of life.^{13,26} The negative impact of living with food allergy in patients and families cannot be overstated.

Although avoidance of peanut protein and rescue treatment have long been the standard of care for individuals with peanut allergy, the findings reported here and in other studies underscore the need for additional measures to prevent unintended allergic reactions. Emerging immunotherapeutic approaches are intended to harness the immune system's features to desensitize an individual with allergy to specific allergens and help reduce risks associated with accidental allergen exposure. Improved allergen risk assessment practices, modifications in food manufacturing, and additional food-labeling requirements not limited to packaged foods are also required to reduce the risk to consumers with allergy and provide safe food choices.

Overall, the data reported herein support that accidental exposure to peanut protein owing to cross-contamination may still occur despite practicing strict avoidance. We found that approximately 1 in 40 bakery items contained unintended peanut. Additional food safety measures and therapeutic approaches to prevent allergic reactions resulting from unintended peanut protein exposure in individuals with peanut allergy are needed.

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