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Detection and quantification of peanut traces in wheat flour by near infrared hyperspectral imaging spectroscopy using principal-component analysis

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The use of a common environment for processing different powder foods in the industry has increased the risk of finding peanut traces in powder foods. The analytical methods commonly used for detection of peanut such as enzyme-linked immunosorbent assay (ELISA) and real-time polymerase chain reaction (RT-PCR) represent high specificity and sensitivity but are destructive and time-consuming, and require highly skilled experimenters. The feasibility of NIR hyperspectral imaging (HSI) is studied for the detection of peanut traces down to 0.01% by weight. A principal-component analysis (PCA) was carried out on a dataset of peanut and flour spectra. The obtained loadings were applied to the HSI images of adulterated wheat flour samples with peanut traces. As a result, HSI images were reduced to score images with enhanced contrast between peanut and flour particles. Finally, a threshold was fixed in score images to obtain a binary classification image, and the percentage of peanut adulteration was compared with the percentage of pixels identified as peanut particles. This study allowed the detection of traces of peanut down to 0.01% and quantification of peanut adulteration from 10% to 0.1% with a coefficient of determination (r^2) of 0.946. These results show the feasibility of using HSI systems for the detection of peanut traces in conjunction with chemical procedures, such as RT-PCR and ELISA to facilitate enhanced quality-control surveillance on food-product processing lines.

Keywords: hyperspectral, NIR, principal-component analysis, food, peanut, adulteration, classification

Introduction

Peanut (*Arachis hypogaea*) is a common economical food source consumed worldwide and has reached approximately 39.9 million metric tons production per year.[1] Concurrently, there is increasing concern regarding peanut allergenic effects and their effects on human health.[2] Peanut allergy is typically lifelong, often severe and potentially fatal, because reactions can occur from very small amounts.[3] The popularity of peanut as a food ingredient in commercial food materials has made it a threat to people allergic to peanut as well as a major concern for food manufacturers. In the food industry, the use of a common environment for grinding peanuts and other food materials, such as wheat, cocoa beans and soybeans, has increased the possibility of finding peanut traces in other powdered food products. The need to detect the peanut traces in the early stages of a food-manufacturing process is therefore of crucial importance. Peanut contains several major protein allergens, and so traditional protein detection methods are widely used for peanut detection in various

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