Detection of peanut traces in wheat flour through NIR hyperspectral imaging spectroscopy

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INTRODUCTION
Peanut (Arachis hypogaea), a common economical food source consumed worldwide, is an increasing concern regarding allergenic effects and their influence on human health. Use of common environment for processing different powder foods in the industry has increased the risk of finding peanut traces in powder foods. Peanut are the leading cause of fatalities from food-induced allergenic reactions, being avoidance the primary management of these allergies.

OBJECTIVE
The objective of the present work was to evaluate the feasibility of HSI for the detection and quantification of peanut traces in wheat flour. For such purpose, different samples of commercial flour adulterated with peanut traces (10 % to 0.01 % by weight) were made with reference peanut samples obtained from European Commission’s Institute for Reference Materials and Measurements.

MATERIAL AND METHODS
Sample preparation:
• Wheat flour (125-100 and 212-160 µm), “Coeur de Blé” from manufacturer MasterChef
• Peanut (500-1000 µm) : obtained from European Commission Institute for Reference Materials and Measurements (IRMW-481kt)
• KERN 770 analytical weighing balance
• Aluminum platforms (36 cm² and 95 cm²) (Fig. a.)
• Eleven samples were made: pure peanut, pure wheat flour, samples with wheat flour and known position of peanut on the surface and eight homogeneously mixed samples from 10% to 0.01% of peanut by weight.

Camera setup:
• HySpex SWIR-320m-e line-scan push broom camera by Norsk Elektro Optikk, Norway.
• Spectral range: 1000 - 2500 nm, sampling gap 6 nm, spatial pixels per line 320
• Halogen light source
• Diffuse reflectance standard by SPECTRALON® (Labsphere, France)

Pre-processing of hyperspectral data:
• Absorbance spectra was used for processing -log10(R) (Fig. c.)
• Standard Normal Variate (SNV) and Savitzky-Golay (15 point window with second order polynomial, no derivative): to reduce environmental and texture effects (Fig. d.)

Data analysis:
• Principal Component Analysis (PCA) with dataset of pure peanut and wheat flour
• PCA loadings were applied to images

RESULTS
PCA results:
• PCA analysis presented 99.43 % of the variance by two main PC : PC1 98.38 % and PC2 1.05 %
• PC1 presented clear differentiation between peanut and wheat flour.
• Variability within products is mainly represented in PC2

Score and classification images:
• Application of PC1 loading helped in enhancing contrast between the peanut and wheat flour pixel.
• After thresholding enhanced contrast images, classification images provide clear detection and quantification of peanut.

CONCLUSIONS
• NIR Hyperspectral images (1000-2200 nm) allowed the detection of peanut traces down to adulteration percentages 0.01%
• Determination coefficient of R²=0.946 was found for the quantification of peanut adulteration from 10% to 0.1%
• The obtained results shows 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 quality control surveyance on food product processing lines.

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