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QUANTITATIVE DETECTION OF BEEF, PORK AND CHICKEN IN MEAT MIXTURES USING FT-NIR SPECTROSCOPY

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Meat and meat products are commonly consumed worldwide because of the essential nutrients and excellent source of proteins they provide. Beef meat has been a target for adulteration, because of its high cost and high demand by the consumers. Near infrared (NIR) spectroscopy has been successfully used to quantify meat composition, i.e. moisture, proteins and fat, but typically, mid-infrared (MIR) spectroscopy has been proposed for the detection of adulteration of beef meat, requiring additional, expensive equipment.

The aim of the present work was to develop a rapid and non-destructive method for the detection of pork and chicken meat in minced beef mixtures using FT-NIR spectroscopy. Beef meat mixtures containing different proportions (0, 25, 50, 75, 100% w/w) of pork and chicken meat were prepared. Two experiments were conducted and 8 samples for each treatment were analyzed. In addition, to take into account the fat content, pork mixed with different percentages of pork backfat (5, 10, 15, 20, 25, 40, 50% w/w) was analyzed. FT-NIR spectra of the samples were acquired using a Jasco FTIR 6700 spectrophotometer equipped with a PIKE NIR integrating sphere. The resulting full spectra (10000 – 4000 cm-1) and selected ranges were analyzed using multivariate analysis techniques to identify and quantify chicken and pork meat addition into beef meat.

The analysis of the spectra showed that the regions 8450 – 8200, 6900, 5800 – 5500, 5200 – 5100 and 4600 – 4200 cm-1 provide effective differentiation for meat adulteration. In addition, blends with different percentages of pork and pork backfat helped to better identify the peaks related to fat content. Principal Component Analysis (PCA) showed the similarities and differences among various mixtures of meat and Partial Least Squares Discriminant Analysis (PLS-DA) demonstrated a good discrimination between binary mixtures containing beef, pork and chicken blends. The PLS-DA with full spectra provided the greatest results with classification rates of 100% for all binary mixtures. Thus, the observed spectral variances between different meats can be used to predict their concentration in the mixtures. For each combination of meats, Partial Least-Square Regression models were bult for predicting the adulteration level, achieving correlation coefficients of 0.879 – 0.925 and root-meat square error of prediction of 7.22 – 9.78.

The results of the FT-NIR spectroscopy confirm that this technique can provide an alternative method to determine the adulteration of meat products and may be utilized by the food industry.

Keywords: Meat adulteration; FT-NIR spectroscopy; Beef; Pork; Chicken; Pork backfat; PCA; PLS-DA

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