Deteksi Adulterasi Daging Babi pada Daging Sapi dan Kambing menggunakan Spektroskopi Vis-NIR dan SWIR dengan Analisis Kemometrika

INTISARI

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Adulterasi daging, khususnya pencampuran daging babi pada daging sapi dan kambing, merupakan isu serius yang melanggar hak konsumen, khususnya umat Muslim. Penelitian ini bertujuan untuk mendeteksi adulterasi daging babi pada daging sapi dan kambing secara kuantitatif dan kualitatif menggunakan spektroskopi Vis-NIR dan SWIR yang dikombinasikan dengan analisis kemometrika. Sebanyak 11 level konsentrasi daging babi (0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, dan 100%) dicampurkan pada daging sapi dan kambing. Spektrum Vis-NIR dan SWIR dari sampel daging diperoleh dan dianalisis menggunakan model *Partial Least Squares Regression* (PLSR) untuk analisis kuantitatif dan *Linear Discriminant Analysis* (LDA) untuk analisis kualitatif. Hasil penelitian menunjukkan bahwa model PLSR dengan pre-processing SNV untuk daging sapi dan *Range Normalization* untuk daging kambing mampu memprediksi tingkat adulterasi dengan akurasi tinggi. Model PLSR untuk daging sapi menunjukkan nilai R^2 0,99 dan RMSE 3,56% untuk data kalibrasi, serta R^2 0,94 dan RMSE 7,37% untuk data validasi. Sedangkan, model PLSR untuk daging kambing menunjukkan nilai R^2 0,92 dan RMSE 8,75% untuk data kalibrasi, serta R^2 0,83 dan RMSE 12,98% untuk data validasi. LDA mampu mengklasifikasikan sampel daging berdasarkan ada tidaknya adulterasi. Hasil terbaik dicapai dengan data Vis-NIR dan pre-processing *Range Normalization* untuk daging sapi dengan akurasi validasi 95,8%, serta tanpa pre-processing (Raw) untuk daging kambing dengan akurasi validasi 86,1%. Penelitian ini menunjukkan potensi spektroskopi Vis-NIR dan SWIR sebagai metode deteksi adulterasi daging yang cepat, akurat, dan non-destruktif.

Kata kunci : adulterasi, daging, babi, spektroskopi, kemometrika, halal

Detection of Pork Adulteration in Beef and Mutton using VIS-NIR and SWIR Spectroscopy with Chemometrics

ABSTRACT

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Meat adulteration, especially the mixing of pork in beef and mutton, is a serious issue that violates consumer rights, especially Muslims. This study aims to detect pork adulteration in beef and mutton quantitatively and qualitatively using Vis-NIR and SWIR spectroscopy combined with chemometric analysis. A total of 11 concentration levels of pork (0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100%) were mixed in beef and mutton. Vis-NIR and SWIR spectra of meat samples were obtained and analyzed using Partial Least Squares Regression (PLSR) model for quantitative analysis and Linear Discriminant Analysis (LDA) for qualitative analysis. The results showed that the PLSR model with SNV pre-processing for beef and Range Normalization for mutton was able to predict the level of adulteration with high accuracy. The PLSR model for beef shows R² of 0,99 and RMSE of 3,56% for calibration data, and R² of 0,94 and RMSE of 7,37% for validation data. Meanwhile, the PLSR model for mutton shows R² of 0,92 and RMSE of 8,75% for calibration data, and R² of 0,83 and RMSE of 12,98% for validation data. LDA was able to classify meat samples based on the presence or absence of adulteration. The best results were achieved with Vis-NIR data and Range Normalization pre-processing for beef with a validation accuracy of 95,8%, and without pre-processing (Raw) for mutton with a validation accuracy of 86,1%. This study demonstrates the potential of Vis-NIR and SWIR spectroscopy as a rapid, accurate, and non-destructive method for meat adulteration detection.

Keyword: adulteration, meat, pork, spectroscopy, chemometrics, halal