Rapid and low-cost detection of moldy apple core based on an optical sensor system

Long Li, Yankun Peng, Yongyu Li, Cheng Yang and Kuanglin Chao

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Abstract

An optical sensor system for the detection of moldy apple core (*Malus domestica* Borkh.) was developed. The cost-effective optical sensor has seven specific wavelengths centered at 425, 455, 515, 615, 660, 700 and 850 nm. However, due to the discrete spectrum, the traditional preprocessing method cannot improve the spectral efficiency. Thus, spectral shape features (SSFs) (i.e., the spectral ratio (SR), spectral difference (SD) and normalized spectral ratio (NSR)) were applied to complete spectral preprocessing and improve the model performance. Principal component analysis was performed prior to linear discriminant analysis modeling (LDA), which can eliminate the multicollinearity problems in the spectral datasets. After LDA models were established, Otsu's method and the maximum entropy (ME) method were proposed for spectral qualitative analysis to determine the optimal threshold. The combination of the NSR, SD and SR, achieved the optimal prediction accuracy. For the calibration set, the accuracy was 98.5 %, and the sensitivity and specificity were equal to 0.98 and 0.99, respectively. The discriminant accuracy was 95.8 % for the independent validation set, and the sensitivity and specificity were equal to 0.97 and 0.95, respectively. The Otsu's method resulted in higher prediction accuracy and was more suitable for threshold determination than the ME method. In summary, the optical sensor system has the advantages of being cost-effective and having a high accuracy, and thus, it is convenient for practical application.