Non-destructive detection and recognition of pesticide residues on garlic chive (*Allium tuberosum*) leaves based on short wave infrared hyperspectral imaging and one-dimensional convolutional neural network

Weiwen He, Hongyuan He, Fanglin Wang, Shuyue Wang and Rulin Lyu

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Abstract

To detect and recognise pesticide residues on garlic chive leaves quickly, accurately and non-destructively, short wave infrared hyperspectral images of 30 garlic chive (*Allium tuberosum*) leaves sprayed with pure water, λ-cyhalothrin, trichlorfon, phoxim and mixtures of trichlorfon and phoxim were collected. The modified mean filtering was used to improve the signal-to-noise ratio of the hyperspectral images, and the isolated forest algorithm eliminated outliers. This study proposed a deep learning model based on one-dimensional convolutional neural network (1D CNN) to recognise pesticide residues on garlic chive leaves and compared this model with k-nearest neighbours, linear discriminant analysis, naive Bayes, random forest and support vector machine. Results show that the accuracy rates of the 1D CNN on the train set, develop set and test set were 98.5%, 98.0% and 97.9%, respectively. Moreover, the areas under the receiver operating characteristic curves of the four classes were all greater than 0.99, suggesting that the accuracy and robustness of the deep learning model were excellent and superior to the five aforementioned traditional classification models. Based on the 1D CNN model, a multi-label classification method was also developed, which gave a satisfactory prediction on the mixed pesticide residue set with a hamming loss of 0.208. Therefore, the combination of hyperspectral imaging technology and deep learning has great potential in the non-destructive detection and recognition of pesticide residues on garlic chive leaves.