Title Assessment of tomato pericarp mechanical damage using multivariate analysis of magnetic resonance images

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Abstract

During steam peeling, severely bruised tomatoes will disintegrate, leading to loss of product. The overall purpose of this study was to develop an in-line method to detect damaged pericarp tissue in processing tomatoes. Magnetic resonance (MR) imaging methods characterize the environment of water protons in plant tissue, resulting in contrast between image pixels corresponding to bruised and sound tissue. Many types of MR imaging protocols are available; in this study, the multivariate image analysis (MIA) method of partial least squares (PLS) was used to determine the optimal MR pulse sequences for tomato pericarp damage assessment. A set of 13 congruent MR images of each of 112 processing tomatoes was used for prediction. The images were created by varying key parameters in 4 different MR pulse sequences. These multivariate images were used to predict the pixel intensities in regions of interest (ROIs) corresponding to the pericarp of the tomato. The pixels in the ROIs for each tomato sample were assigned a value between 0 (no damage) and 1 (extensive damage), corresponding to the conductivity score for that sample, measured after imaging. PLS models of 1–13 latent variables were generated, and cross validation was performed. The root mean square error of cross validation (RMSECV) of the PLS models leveled off after 8 latent variables, so this model was used for conductivity score prediction. The 8 latent variable model captured 97% of the variance in the independent variable (the MR images) and 54% of the variance in the dependent variable (the conductivity scores). The Variable Importance in Projection scores for the 13 MR image sequence types in the chosen model indicated that the Fast Spin Echo sequence with receiver gain of 10 and Turbo Fast Low-Angle Shot sequences with inversion times of 400 ms, 800 ms, 1000 ms, and 1200 ms had the strongest influence on the model. The root mean square error of calibration (RMSEC) and RMSECV of a final model including only these five sequences were low: 0.16 and 0.17, respectively. Thus, MIA of MR images of tomato proved to be effective for predicting the conductivity score of pericarp tissue in tomatoes.