Title Measurement and evaluation of tomato maturity using magnetic resonance imaging

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Citation Postharvest Biology and Technology. Volume 67, May 2012, Pages 37–43

Keywords Tomato; Maturity; Magnetic Resonance imaging (MRI), PLS-DA; T_2; Diffusion rate

Abstract

Tomato maturity is one of the most important factors associated with the quality of processed tomato products. Magnetic resonance imaging (MRI) is capable of probing the local environment and density of water protons, and encoding the differences in water properties in the form of contrast in image signal intensity. This study investigated changes in tomatoes at different maturity using MRI and the potential for using MRI for tomato maturity classification. A set of 5 MR images was collected on processing tomatoes at various maturity stages. The 5 MRI sequences were selected so that information on water proton properties, including proton density, T_1, T_2, and diffusion rate, are encoded in the MR image signal intensity. A relative water diffusion rate map was also calculated. Changes in structural features and volume element (voxel) intensity in the images were observed as tomatoes develop from green to red stage. In image analysis, voxels in the region of interest (ROI) corresponding to the pericarp of the tomato were used to calculate statistical features of the voxel intensity for image characterization. Partial least square discriminant analysis (PLS-DA) was applied to a total of 48 image features calculated from 5 MR images of 144 processing tomatoes to predict the tomato maturity. The model with 4 latent variables captures 70% of the variation in tomato maturity. The classification accuracies of the PLS-DA model were around 90% for green, breaker-light red, and red maturity stages. The Variable Importance in Projection coefficient of the 48 image features in the model indicated that the diffusion weighted image and spin echo image with higher T_2 weighting were most important for tomato maturity classification.