Abstract

In pomegranate, black heart disease develops inside the fruit without affecting the rind. Visual inspection is not effective for identification of black heart in pomegranate fruit because of the lack of external symptoms. It has been shown that the water proton T_2 relaxation time is sensitive to cell compartmentalization. Proton NMR relaxometry was used to investigate the water T_2 relaxation distribution in infected and healthy pomegranate arils, and to obtain information that indicates tissue damage. Multi-exponential inversion of the T_2 data of healthy arils gave three relaxation peaks, which correspond to different water compartments in tissue. In infected arils, the three relaxation components shifted to lower relaxation time and a new fast relaxation component appeared indicating there was water redistribution among cell compartments caused by the infection. The change in cell membrane integrity in arils was also investigated with the aid of paramagnetic ions. T_2-weighted fast spin echo images were acquired for healthy and pomegranates with black heart. Histogram features of images, including mean, median, mode, standard deviation, skewness, and kurtosis, were examined using partial least square discriminant analysis (PLS-DA). The PLS-DA model based on histogram features of MR image showed 92% accuracy in detecting the presence of black heart in pomegranate fruit. The significant change in T_2 relaxation distribution in arils after infection proved that T_2 relaxation time is a good indicator of black heart in pomegranate. The T_2 based MR imaging showed its potential as a nondestructive technique for black heart detection in pomegranate.