Title Effects of internal browning and watercore on low field (5.4 MHz) proton magnetic resonance measurements of T2 values of whole apples

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Abstract

Apples with internal browning and/or watercore along with unaffected apples were tested using a low frequency (5.4 MHz) proton magnetic resonance (^{1}H MR) sensor. A three-term exponential model was fit to the spin–spin relaxation (T_2) curves obtained from individual apples. The contributions from terms of the model associated with extracellular spaces, *a* (ca. 16 ms) and the cytoplasm, *b* (ca. 300 ms) increased with the severity of internal browning (r^2 = 0.7, 0.9, respectively). Conversely, the contribution of the term associated with water in the vacuoles, *c* (ca. 1260 ms) decreased as the severity of internal browning increased (r^2 = 0.9). The changes in the model parameters were different for apples having only internal browning compared to apples with both moderate watercore and slight or no internal browning and the differences were statistically significant ($P < 0.05$). Percent total soluble solids (TSS) in the apples was not affected by the severity of the internal browning for apples with moderate watercore while it increased with severity of internal browning for apples without moderate watercore. In addition, the density of the apples decreased as the contribution of the term associated with water in the vacuoles increased. Finally, two of the model parameters were significantly correlated with TSS in unaffected apples and one parameter was significantly correlated with TSS in apples with moderate watercore and no internal browning ($r^2 \simeq 0.7$). The results of this study suggest that when a three-term exponential model is fit to the T_2 relaxation curve from a low field ^{1}H MR sensor, the changes in the parameters may give an indication of the presence and severity of internal browning as well as the presence of watercore in the apple.