Abstract

Apple (Malus domestica Borkh.) fruits often develop the physiological disorders senescent breakdown and superficial scald following storage at low temperature. Possible relationships of lipid peroxidation with these physiological disorders in apples, and of accumulation and metabolism of α-farnesene with scald development, were investigated.

Preharvest treatments modified lipid peroxidation and activities of associated enzymes. During postharvest storage, superoxide dismutase activity declined and catalase and peroxidase activities increased in fruit peel. At 0 °C and 20 °C, lipid peroxidation products and enzyme activities generally changed significantly shortly after harvest, and then these changes become more gradual. Some differences existed in patterns of changes over time between temperatures, but they had little association with differences that developed in fruit between temperatures. Lipid peroxidation was not directly associated with scald development. However, senescent breakdown areas that developed on fruit surfaces had elevated lipid peroxidation products and enzyme activities. In model systems, malondialdehyde was oxidized by hydrogen peroxide and by light-excited riboflavin.

Two groups of conjugated triene (CT) species were separated, namely, CT281 which was correlated positively with scald, and CT258 which was correlated negatively with scald. CT258 appeared to be a metabolite of CT281, and scald development to be regulated by both formation and metabolism of CT281. A high CT258/CT281 ratio always was associated with low scald development.

Ethylene had opposing effects on scald induction: synthesis and metabolism of α-farnesene were enhanced immediately, but during prolonged storage relative concentrations of the two CT species were altered, increasing the CT258/CT281 ratio. Effects of many environmental, physiological, and chemical factors were ethylene-mediated responses. For example, treatment with the antioxidant diphenylamine immediately suppressed ethylene and α -farnesene production, but over time in storage suppressed CT281 and increased CT258, thus increasing CT258/CT281 ratio. Other factors such as fruit size, cultivar differences, warming interruption of cold storage, and fruit maturity also affected the α -farnesene pathway. In all cases scald development was more associated with metabolism of CT281 than with its accumulation. From these findings, a new hypothesis for the biochemical mechanism of scald development was proposed.