

Title Molecular analysis of softening and ethylene synthesis and signaling pathways in a non-softening apple cultivar, 'Honeycrisp' and a rapidly softening cultivar, 'McIntosh'

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Abstract

A feature of 'Honeycrisp' apples [*Malus sylvestris* (L.) Mill var. *domestica* (Borkh.) Mansf.] is that they maintain flesh firmness over extended storage. The objective of this study was to elucidate molecular mechanisms that are responsible for slow softening of 'Honeycrisp' as compared with a rapidly softening cultivar, 'McIntosh'. Fruit from both cultivars were picked during the normal harvest period and stored at 20 °C for 10 d. Internal ethylene concentrations (IECs) in 'Honeycrisp' fruit were lower than in 'McIntosh', but at climacteric levels of ethylene 'Honeycrisp' fruit maintained their firmness over this period, while 'McIntosh' softened rapidly. Concentrations of the ethylene precursor 1-aminocyclopropane-1-carboxylic acid (ACC) were higher in 'Honeycrisp' than in 'McIntosh' apples. qRT-PCR analysis was carried out for genes involved in ethylene biosynthesis, perception and signaling [ACC synthase (*MdACS*); ACC oxidase (*MdACO*); ethylene receptors (*MdETR* and *MdERS*); constitutive triple response (*MdCTR*); ethylene response factor (*MdERF*)], as well as those involved in cell wall metabolism [polygalacturonase (*MdPG*); xyloglucan endotransglucosylase (*MdXTH*); expansin (*MdEXP*); β -galactosidase (*Md β -GS*); arabinofuranosidase (*MdAFase*); pectate lyase (*MdPL*)]. At comparable IECs, the expression of genes involved in ethylene synthesis, ethylene perception and signal transduction was generally much higher in 'Honeycrisp' than in 'McIntosh' fruit. However, the expression of *MdAFase* and *MdEXP3* was generally lower in 'Honeycrisp' than in 'McIntosh', while that of *MdPG* and *MdPL* was extremely low in 'Honeycrisp'. Expression of *MdPG1* was very low, even though IECs were at climacteric levels. Absence of fruit softening in 'Honeycrisp' is probably associated with restricted cell wall enzyme activity. The lower maximum IECs found in 'Honeycrisp' compared with 'McIntosh' do not appear to be related to expression of genes involved in ethylene biosynthesis.