Title Expression of ripening-related genes in cold-stored tomato fruit

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Abstract

The effects of chilling on fruit ripening and the expression of ripening-related genes have been investigated in M82IL2-2, a wild species introgression breeding tomato line (*Solanum lycopersicum* × *Solanum pennellii*). Fruit harvested at the breaker stage of ripening were stored at 3 °C for 0, 1, 2 and 4 weeks, followed by 20 °C for 0–14 d. Fruit stored for 1 week ripened normally, as assessed by red color development and softening at 20 °C, but those stored for 2 or 4 weeks showed delayed or inhibited ripening. The concentrations of the carotenoids, phytoene, phytofluene, zeta (ζ)-carotene, gamma (γ)-carotene and lycopene, but not lutein and β-carotene, were reduced in chilled fruit. Microarray analysis showed that after storage at 3 °C for 4 weeks, 352 genes were up-regulated by chilling, whereas 321 genes were down-regulated, while after 7 d at 20 °C, 180 and 126 genes, respectively, were up- and down-regulated in chilled fruit. Chilling-induced changes included expression of transcriptional repressors such as a C2H2-type zinc finger protein. Expression of genes involved in color development, including phytoene synthase1 (*PSY1*), carotenoid isomerase (*CRTISO*), geranylgeranyl diphosphate synthase 2 (*GGPPS2*), and 1-deoxy-d-xylulose-5-phosphate synthase (*DXS*), showed reduced expression during and after chilling, as did genes encoding the cell wall modifying proteins polygalacturonase (PG), pectin esterase1 (PE1), β-galactosidase (*TBG4)*, expansin1 (*LeExp1*), and xyloglucan endotransglucosylase-hydrolase 5 (*XTH5*). Alcohol dehydrogenase 2 (*ADH2*) and alcohol acyltransferase (*AAT*) gene expression was also reduced by chilling. Alteration of ethylene production correlated with the altered ACC synthases (*ACS2*, *ACS4*), and ACC oxidase (*ACO1*) expression. The expression of genes involved in the ethylene signal transduction pathway, such as *LeETR1*, *NR*, *LeETR4*, *LeCTR1*, *LeEIL3*, *LeEIL4*, and *LeERF3*, was altered by chilling, suggesting that ethylene perception and sensitivity were affected. Chilling also reduced gene expression of a ripening-regulated transcription factor, *LeMADS-RIN*. The effect of chilling on ethylene biosynthesis, ethylene perception, the expression of a transcription factor necessary for ripening, and transcriptional repressors may contribute to the alteration of fruit ripening in tomato.