Involvement of phospholipases and sucrose in carbon starvation-induced non-chilling peel pitting in citrus fruit

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Abstract

The involvement of different isoforms of genes encoding phospholipases D (*CsPLDα, CsPLDβ, CsPLDδ, CsPLDγ* and *CsPLDζ*) and A_2 (*CsPLA$_2$α, CsPLA$_2$β* and *CsPAT1*) on starvation-induced postharvest non-chilling peel pitting (NCPP) has been compared in the inner (albedo) and outer (flavedo) parts of the peel of citrus fruit treated or not with sucrose (Suc). The study has been performed in Navelate (*Citrus sinensis* (L.) Osbeck) sweet orange, which is prone to NCPP, stored under non-stressful environmental conditions (90–95 % relative humidity (RH) and 20 °C). Transcriptional changes, as well as respiration rate and ATP content evolution during fruit storage were compared in both peel tissues. Results indicated that the albedo is more susceptible than the flavedo to starvation; and that, at early stress stage, ATP and all *CsPLD* isoforms and *CsPLA$_2$β* are good indicators of carbon starvation in the albedo, and *CsPLDβ* in the flavedo. These carbon starvation-induced signals were not activated when Suc was applied as an external energy source. In the second phase of starvation, expression of all *CsPLD*-encoding genes increased with NCPP; and *CsPLDγ* and *CsPLDζ* showed major increases in both peel tissues. The correlation of the expression of *CsPLA* isoforms with damage development was lower. In this phase, Suc may protect the fruit by providing additional energy sources to sustain respiration; and by favouring phospholipid-derived signaling messengers mediated by *CsPLDβ* and *CsPAT1* in the albedo, *CsPLDζ* in the flavedo, and *CsPLA$_2$β* in both tissues. Results from the examination of changes in gene expression point out tissue specificities in the expression of *CsPL* genes but also different susceptibility to starvation between the flavedo and the albedo in citrus fruit.