# Conjugated trienols and programmed cell death are more closely related to superficial scald than reactive oxygen species in apple fruit stored at low temperature

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## Abstract

Superficial scald is a physiological disorder affecting apple fruit during cold storage. Previous studies have reported that multiple factors, such as α-farnesene, ethylene, conjugated trienols (CTols), reactive oxygen species (ROS), and programmed cell death (PCD) are associated with superficial scald. However, the correlation between the factors and scald severity under different storage durations has rarely been reported. In this study, we analyzed how these factors change over time (0 d, 7 d, 30 d, 60 d and 90 d) in association with the incidence of scald in 'White Winter Pearmain' apples at low-temperature (5 ℃). The results showed that the time for scald to development is short and the incidence of scald increases with storage time. The highest level of α-farnesene was observed after 7 d, whereas, the production rate of CTols, $O_2^-$, $H_2O_2$, and ethylene gradually increased with time. In addition, specific expression profiling of *MdDAD1*, *MdLSD1* and *MdDND1* suggested that PCD was involved with scald development. The correlation analysis showed that content of CTols, the production rate of ethylene, and the expression of *MdAFS*, *MdHMGR2*, *MdACS1*, *MdACO1*, *MdDAD1*, and *MdLSD1* were strongly associated with superficial scald, whereas, α-farnesene and ROS were weakly associated. These results suggest that CTols and PCD are associated with scald development and that their role is more prominent than ROS. This is a novel perspective on the cause of scald that-can help develop potential solutions to inhibit scald development.