Extending ‘Granny Smith’ apple superficial scald control following long-term ultra-low oxygen controlled atmosphere storage

Brenton C. Poirier, James P. Mattheis and David R. Rudell

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Abstract

Superficial scald is an apple postharvest peel browning disorder that contributes to annual losses of susceptible cultivars, principally where crop protectants that control the disorder are restricted. Controlled atmosphere (CA) storage reduces or eliminates superficial scald while apples remain in storage, especially when pO_2 is maintained below 1 kPa. However, symptoms often develop during the post-storage cold chain, which can last beyond a month. Diphenylamine (DPA) or 1-methylcyclopropene (1-MCP) treatment can be used to control scald, but application is required within the first weeks of cold air storage following harvest. After this period, treatments are no longer effective due to irreversible physiological changes, hereby referred to as “scald induction”. As a recent report indicates, apple flesh softening can be reduced by 1-MCP treatment following ultra-low oxygen CA (ULO-CA) storage ($pO_2 \leq 1.0$ kPa). Here, we sought to determine if ULO-CA would also preserve the capacity to control scald with post-CA treatments. To determine this, ‘Granny Smith’ apples were treated with hot water and 1-MCP at harvest or following long-term (>3 months) in-house and commercial ULO-CA for two consecutive years. Different CA storage environments (2.0 kPa and 1.0 kPa O_2) and delays in ULO-CA establishment were used in combinations with delayed DPA and 1-MCP treatments to reveal the scald induction timeline and how different storage practices may impact the effectiveness of post-CA scald control measures. Taken together, results indicate that scald induction is effectively delayed during ULO-CA storage and resumes upon return to air storage. 1-MCP and hot water treatments applied after four months of ULO-CA storage were equally effective at controlling scald during subsequent air storage as treatments applied at harvest. However, the efficacy of post-storage treatments relied on the rapid establishment and maintenance of ULO conditions and immediate treatment upon

removal from ULO-CA storage. Scald induction resulted from cumulative oxygen exposure occurring prior to, during (pO_2) and following CA storage. Conjugated trienol and acylated steryl glycoside levels at the end of ULO-CA storage reflected how much scald induction had occurred and, likewise, the efficacy of post-storage scald mitigation treatments.