Title Ripening, storage temperature, ethylene action, and oxidative stress alter apple peel phytosterol metabolism

Author David R. Rudell, David A. Buchanan, Rachel S. Leisso, Bruce D. Whitaker, James P. Mattheis, Yanmin Zhu and Vijay Varanasi

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Abstract

The chilling conditions of apple cold storage can provoke an economically significant necrotic peel disorder called superficial scald (scald) in susceptible cultivars. Disorder development can be reduced by inhibiting ethylene action or oxidative stress as well as intermittent warming. It was previously demonstrated that scald is preceded by a metabolomic shift that results in altered levels of various classes of triterpenoids, including metabolites with mass spectral features similar to β-sitosterol. In this study, a key class of phytosterol metabolites was identified. Changes in peel tissue levels of conjugates of β-sitosterol and campesterol, including acylated steryl glycosides (ASG), steryl glycosides (SG) and steryl esters (SE), as well as free sterols (FS), were determined during the period of scald development. Responses to pre-storage treatment with the ethylene action inhibitor, 1-methylcyclopropene, or an antioxidant (diphenylamine), rapid temperature elevation, and cold acclimation using intermittent warming treatments were evaluated. Diphenylamine, 1-MCP, and intermittent warming all reduced or prevented scald development. ASG levels increased and SE levels decreased in untreated control fruit during storage. Removing fruit from cold storage to ambient temperature induced rapid shifts in ASG and SE fatty acyl moieties from unsaturated to saturated. FS and SG levels remained relatively stable during storage but SG levels increased following a temperature increase after storage. ASG, SE, and SG levels did not increase during 6 months cold storage in fruit subjected to intermittent warming treatment. Overall, the results show that apple peel phytosteryl conjugate metabolism is influenced by storage duration, oxidative stress, ethylene action/ripening, and storage temperature.