

A convergence of sunlight and cold chain: The influence of sun exposure on postharvest apple peel metabolism

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Abstract

Excess solar irradiation is responsible for commercially significant annual losses of apple fruit, and those losses are expected to increase in the majority of the world's apple production regions. Losses are not limited to the orchard but are also represented by disorders that develop in the cold chain such as sunscald and elevated lenticel damage. Similarly, metabolism during storage would reflect changes and even diverge during ripening and cold storage depending upon relative amount of light exposure in the orchard. To determine and track these changes alongside changes of appearance, 'September Wonder Fuji', 'Gala', 'Granny Smith', and 'Honeycrisp' apples were selected from the periphery on the south-facing side of trees for contrasting sun exposure on opposite aspects, stored in 1 °C air, and peel from opposing sides sampled sequentially from 0 to 6 months. Additional sunburned peel was sampled at 0 and 6 months. Sun exposure provoked broad relative responses from multiple pathways indicative of solar stress response. Responses include accumulation of well-characterized photoprotective responses including accumulation of flavonol glycoside and carotenoid, compatible solutes, and primary metabolites. Others include previously unreported or lesser understood responses such as those potentially impacting membrane properties (including changes in levels of monogalactosyldiacylglycerides and stigmasteryl glycosides), epicuticular surface metabolites (including pentacyclic triterpenes and diacylglycerides), and production of volatile alkenals indicative of residual solar stress during storage. Taken together, metabolic evidence indicates orchard light environment continues to impact not only appearance, but also rate of ripening and potentially fruit quality, even on the same apple. In this way, light exposure of any given apple could influence every cold chain management decision, and sorting apples at-harvest according to cumulative light exposure would improve apple consistency while potentially avoiding losses due to peel disorders.