

Title Apple (*Malus domestica* Borkh.) fruit skin disorders and changes in pigment concentrations associated with the disorders

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Abstract

Apple fruit sunburn and 'Fuji' stain cause great economic losses, and are a direct result of pigment changes that cause discoloration. 'Fuji' stain appears during cold storage on the sun-exposed side of apples that have been sunburned. These disorders were characterized with in-depth analyses of compounds involved in apple color development and how changes in the concentrations of these compounds are associated with sunburn and 'Fuji' stain.

As severity of sunburn increased in 'Fuji' apples, concentrations of chlorophylls a and b, and idaein decreased. A sudden increase in total quercetin glycosides and β -carotene upon initial sunburn was observed. The hue angle (h°) was highly correlated to the concentrations of total chlorophylls, idaein, and total quercetin glycosides.

In a second study, comparison of the sun-exposed side of non-sunburned apples to three different areas of the sun-exposed side of sunburned 'Fuji', 'Gala', 'Delicious', 'Golden Delicious', and 'Granny Smith' apples revealed differential responses of carotenoids to sunburn. β -carotene concentrations in the peel of 'Fuji' and 'Delicious' apples decreased as the distance from the sunburned area increased while in 'Granny Smith' it increased. The chlorophyll concentrations of all five cultivars and the idaein concentration of the red cultivars increased as the distance away from the sunburned area increased, while the quercetin glycoside concentrations decreased. The h° was highly correlated to the chlorophyll, quercetin glycoside, and idaein concentrations (red cultivars only). The h° was also highly correlated to the carotenoid concentration for 'Fuji', 'Delicious' and 'Golden Delicious'.

In a third study, discolored peel from apples with 'Fuji' stain was compared to various peel types from apples not exhibiting stain [i.e. sunburned peel, area around sunburned peel (halo), and area around halo (OH); the sun-exposed side of non-stained non-sunburned apples (NSNB) and non-discolored peel outside stained area (OS)]. Concomitant low concentrations of idaein, quercetin glycosides, and epicatechin in peels with stain are in contrast to my earlier studies regarding sunburn and appear to be a unique characteristic of the stained peel of 'Fuji'.

Results of these studies demonstrate the important role of pigments in the development of two important apple skin disorders.