Title Metabolic alteration in 1-MCP treated 'Empire' apples during storage

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Abstract

'Empire' apples are susceptible to firm flesh browning when stored at temperatures close to 0 °C, or after 1-methylcyclopropene (1-MCP) treatment when stored at warmer temperatures such as 3 or 4 °C. This study was designed to examine the effects of 1-MCP on metabolic responses of fruit stored at 2 kPa O_2 /2 kPa CO_2 at either 0.5 or 3.3 °C for up to 40 weeks. The incidence of flesh browning was higher in 1-MCP treated fruit than in untreated fruit at either storage temperature. 1-MCP reduced nitroblue tetrazolium reducing activity but inconsistently affected H_2O_2 concentrations. 1-MCP increased malondialdehyde concentrations at 0.5 °C but not at 3.3 °C. 1-MCP treated fruit had lower ascorbic acid concentrations at the end of storage. 1-MCP resulted in lower glutathione concentrations but higher oxidized glutathione concentrations at the end of storage at 3.3 °C. While 1-MCP reduced copper/zinc-superoxide dismutase activity at 3.3 °C, it increased peroxidase activity at 3.3 °C. Overall, however, 1-MCP did not affect the activities of the other antioxidant enzymes consistently, and no direct association between antioxidant metabolism and flesh browning development was revealed. Partial least squares discriminant analysis revealed different metabolic divergence and separation by 1-MCP and storage temperature. Regardless of 1-MCP and storage temperature, malic, succinic and 2-oxoglutaric acid concentrations decreased, while carbohydrates were not affected. 1-MCP increased sorbitol, tryptophan, phenylalanine, glutamate, 5-oxoproline, aspartate, homoserine, threonine, isoleucine, valine, leucine, serine, chlorogenic acid, phloridzin and catechin concentrations at 3.3 °C. 1-MCP reduced volatile compounds, and levels were highest in untreated fruit at 3.3 °C. The partial least squares discriminant analysis loading plots indicated that sorbitol and γ-aminobutyric acid could be associated with the development of flesh browning in 1-MCP treated fruit stored at 3.3 °C. Overall, the development of flesh browning is likely to be complex, resulting from the interaction of several metabolic pathways.