

Title Effects of 1-methylcyclopropene on antioxidant status and external carbon dioxide injury of 'Empire' apples

Author Fanjaniaina Razafimbelo and Christopher B Watkins

Citation Thesis, Doctor of Philosophy (Horticulture), Cornell University. 104 pages. 2009.

Keywords Apples; *Malus x domestica cv Empire*; Methylcyclopropene; Storage; Ethylene; Carbon dioxide injury; Antioxidant activity; Carbon dioxide

Abstract

Extensive studies have suggested that apple consumption is associated with prevention of chronic diseases such as cardiovascular disease, certain cancers, diabetes and asthma as apple is a rich source of phytochemicals with strong antioxidant and antiproliferative activity. 1-Methylcyclopropene (1-MCP), an ethylene inhibitor has been extensively used by the apple industry to maintain quality of various apple cultivars. In New York, use of 1-MCP has been especially high because it maintains firmness throughout the marketing chain. The use of 1-MCP has raised two issues that are addressed in this thesis. The first is the relatively small amount of information about the effects of 1-MCP on nutritional quality of apple fruit. The second is that 1-MCP appears to increase susceptibility of certain cultivars to physiological injuries, and in 'Empire', external CO₂ injury.

The effect of 1-MCP treatment on the phytochemical concentrations and activity and ascorbic acid concentrations of 'Empire' apple as affected by air and controlled atmosphere (CA) storage was investigated. Fruit were stored in air for up to 5 months, and in CA in 2 and 3 kPa O₂ (2%CO₂) at 0.5 and 2.2°C for 4.5 and 9 months. Ripening was delayed by 1-MCP treatment in both air and CA storage as indicated by internal ethylene concentrations and flesh firmness. Overall, total phenolic, flavonoid and anthocyanin concentrations as well as antioxidant activity are relatively stable during air and CA storage. In CA, interactions among oxygen level, temperature and storage duration were detected but no consistent trends were observed. The only effects of 1-MCP on flavonoid or anthocyanin concentrations of fruit stored in CA were found in the flesh. Flavonoid concentrations were higher in the flesh of 1-MCP treated than untreated fruit kept in 2 kPa O₂ while anthocyanin concentrations only measured in the peel were not affected. Phenolic concentrations were higher in the peel while lower in the flesh of 1-MCP treated fruit compared to the control fruit stored in air. There were no correlations found between total phenolics and antioxidant activity. Ascorbic acid concentrations declined in both peel and flesh tissues of untreated and 1-MCP treated fruit stored in air. In CA, the change was affected by several storage parameters and there were inconsistent pattern in the decline of ascorbic acid concentrations in CA-stored fruit.

The effects of CO₂ partial pressure, the timing of elevated CO₂ exposure, delays between harvest and exposure to elevated CO₂, DPA concentration, and the timing of DPA treatment after exposure of fruit to 1-MCP on the susceptibility of untreated and 1-MCP-treated 'Empire' apple fruit to external CO₂ injury have also been investigated. 1-MCP-treated fruit were more susceptible to external CO₂ injury than untreated fruit when stored in 5 kPa, but not 1 kPa CO₂ (in 2 kPa O₂). 1-MCP did not increase the period of highest susceptibility to injury during CA storage. The greatest sensitivity to injury occurred 0-3 weeks after harvest. Sensitivity to injury decreased when untreated fruit were kept in air for up to 14 days before exposure to 5 kPa CO₂, but not for 1-MCP-treated fruit. DPA treatment prevented development of CO₂ injury even at a level as low as 250 μL L⁻¹. DPA treatment could be delayed for 4 days after 1-MCP treatment while fruit were exposed to 5 kPa CO₂ in air without injury development.