Title 1-Methylcyclopropene sorption by tissues and cell-free extracts from fruits and vegetables: Evidence for enzymic 1-MCP metabolism

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Abstract

Non-specific sorption of 1-MCP has been demonstrated for a number of fruit and vegetable tissues. In experiments examining comparative sorption of 1-MCP gas (765 μmol m^{-3}, 18.2 μL L^{-1}) to whole and processed apple fruit, sorption rate increased from 3.0 ± 0.2 ng kg^{-1} s^{-1} in intact fruit to 13.8 ± 2.4 and 28.2 ± 1.5 ng kg^{-1} s^{-1} in halved and fresh-cut wedges, respectively. Sharply enhanced sorption was also observed in whole fruit in response to peeling, indicating that sorption was restricted by epidermal tissue and/or enhanced in response to tissue wounding. Sorption to fresh-cut apple was reduced nearly 90% in response to tissue heating. Heat inactivation of 1-MCP sorption was not a consequence of cellular disruption, as frozen–thawed tissue retained around 76% of initial sorption rate and 95% of sorption capacity over 6 h. High 1-MCP sorption was also exhibited by asparagus spears. Sorption rate and capacity of asparagus spears were unaffected by tissue wounding and were inhibited 54 and 50%, respectively, following a freeze–thaw cycle. As with apple tissue, sorption of 1-MCP to asparagus tissue was inactivated (>90%) following tissue heating. The strong inhibition by heating indicated that metabolism participates in tissue 1-MCP consumption. Subsequent analysis revealed that cell-free homogenates (CFH) from apple fruit tissue metabolized 1-MCP at rates approaching 80 ng kg^{-1} s^{-1}. Activity was negligible in buffer-insoluble residue (BIR). Standard 1-MCP metabolism assays utilized 10 mL CFH from 5.0 g of tissue along with 10 mL 125 mol m^{-3} Na-MES, pH 5.0. The solutions were sealed in 244 mL jars and provided with 420.5 μmol m^{-3} (10 μL L^{-1}) gaseous 1-MCP (SmartFresh™ Technology). 1-MCP metabolism in apple CFH displayed saturation kinetics, with a K_m of 160 mmol m^{-3} and V_{max} of 4.12 μmol kg^{-1} s^{-1}, occurred optimally at pH 5, and was inhibited by heating (>90%), ascorbate (83% at 4 mol m^{-3}), hypoxia (45% at 0.25 kPa O_2), and sodium docecyl sulfate (SDS, 63% at 34 mol m^{-3}). 1-MCP metabolism was also detected in CFH from plantain peel but not pulp, consistent with the high and low sorption capacities of the respective tissues. High sorptive properties of asparagus spears were not evident in CFH, which showed no detectable 1-MCP metabolism. CFH from asparagus reduced 1-MCP metabolism in apple fruit CFH by 75%, providing evidence for compounds in asparagus that inhibited 1-MCP metabolism. The data suggest that membrane-associated, enzymic oxidation rather than physical sorption constitutes the primary sink for 1-MCP applied to fruit and vegetable tissues.