

Postharvest 1-methylcyclopropene application delays leaf yellowing of pak choi (*Brassica rapa subsp. chinensis*) by improving chloroplast antioxidant capacity and maintaining chloroplast structural integrity during storage at 20 °C

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Abstract

The aim of this study was to uncover the regulatory mechanism underlying the leaf yellowing of pak choi after 1-methylcyclopropene (1-MCP) treatment at (20 ± 0.5) °C. The ultrastructural, physiological and biochemical metabolism changes of the chloroplast in pak choi were investigated. Chlorophyll degradation was effectively alleviated by 1-MCP treatment, and the market life of pak choi was extended by 2 days compared with that of control. Electron microscopy confirmed that the chloroplast breakdown was reduced by 1-MCP. This treatment not only preserved the high activities of chloroplast antioxidant enzymes (superoxide dismutase SOD and ascorbic peroxidase APX) and non-enzymatic antioxidants (ascorbate-glutathione (AsA-GSH)) for scavenging reactive oxygen species (ROS) (superoxide anion $O_2^{\cdot-}$ and hydrogen peroxide H_2O_2), but also decreased the chloroplast chlorophyll-degrading peroxidase (Chl-POX) activity, thus retarding chlorophyll degradation in the peroxidase- H_2O_2 system. Abundant $O_2^{\cdot-}$ and H_2O_2 may function as major toxic molecules to enhance the activities of chloroplast phospholipase (PLD), lipoxygenase (LOX) and lipase. The loss of the chloroplast structural integrity and function caused by the high activities of PLD, lipase and LOX aggravated the enzymatic degradation of chlorophyll in pak choi, which was rescued by using 1-MCP that retarded the degradation of the chloroplast membrane, as well as maintained high unsaturated fatty acid levels and low malondialdehyde (MDA) level. In conclusion, 1-MCP fumigation may augment the chloroplast antioxidant capacity for scavenging ROS ($O_2^{\cdot-}$ and H_2O_2), which attenuated the activities of chloroplast PLD, lipase and LOX, inhibited the degradation of the chloroplast membrane and kept the membrane integrity and normal function, ultimately relieving the yellowing of pak choi.