Gaseous chlorine dioxide increases energy status and energy metabolism-related enzyme activities leading to reduction in pericarp browning of longan fruit during storage

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Abstract

Senescence in plants is governed by intrinsic developmental programs which is often under the regulation of their cellular energy status. Changes in energy production and energy metabolism-related enzyme activities contribute to senescence in plants. This study aimed to investigate the effects of gaseous chlorine dioxide (ClO_2) in reducing pericarp browning related to energy metabolism. Fresh longan fruit were fumigated with 0 (control) and 10 mg L^{-1} ClO_2 for 10 min and then stored in a cardboard box at 25 ± 1 °C with 82% relative humidity for 7 d. It was shown that the activities of energy metabolism-related enzymes, including nicotinamide adenine dinucleotide dehydrogenase, succinate dehydrogenase, cytochrome c oxidase, succinyl-CoA synthetase and ATPase (H^+-adenosine triphosphatase, Ca^{2+}-adenosine triphosphatase and Mg^{2+}-adenosine triphosphatase) decreased during storage. The decreases in the enzyme activities coincided with the decreases in adenosine triphosphate content and energy charge, as well as an increase in pericarp browning of longan. ClO_2 treatment increased the energy status significantly and the activities of energy metabolism-related enzymes during the first 2–5 d of storage. Furthermore, ClO_2 increased succinyl-CoA and succinate contents as well as respiration rate in the first day of storage. The increases in cellular energy and the activities of energy metabolism-related enzymes by ClO_2 were closely associated with the reduction in pericarp browning. It can be concluded that the decline in cellular energy and the activities of enzymes related to energy metabolism involved in browning development of longan fruit and ClO_2 could promote and maintain energy production by enhancing the energy metabolism-related enzyme activities, leading to the reduction in pericarp browning of longan fruit during storage.