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Reactive oxygen species promotes chlorophyll degradation and senescence in 'Jinda' chili during storage

Abstract

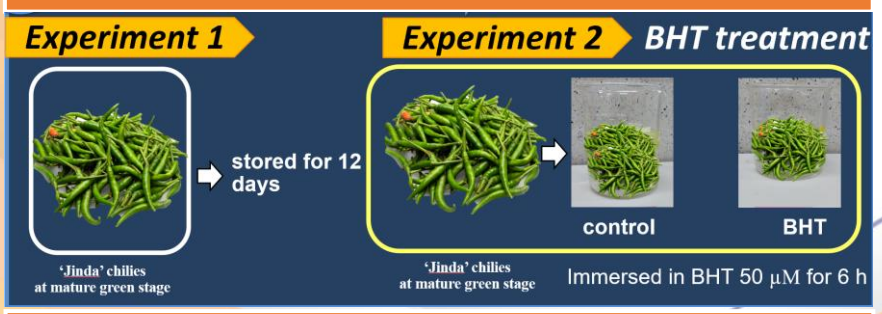
Reactive oxygen species (ROS) play a crucial role in controlling plant senescence and physiological disorders. The objective of this study was to investigate the impact of ROS accumulation on chlorophyll degradation and senescence of chili fruit during storage. Mature green chili (5 replicates, 100 fruit per replication) was examined for ROS, antioxidant systems, chlorophyll catabolic enzymes and cell death-related enzymes during 12 d of storage. On day 3 of storage, vanishing of chili greenness was observed coinciding with elevated ROS (superoxide and hydrogen peroxide) levels and raising in chlorophyll catabolic enzymes (chlorophyll peroxidase, chlorophyllase and pheophytinase activities) In contrast, the antioxidant enzymes (ascorbate peroxidase, superoxide dismutase and catalase) were found to be reduced. In addition, the massive cell death hallmarks (caspase-like enzymes and DNA degradation) were remarkably detected throughout the degenerative period. Interestingly, ROS scavenging agent (butylated hydroxytoluene) maintained pericarp greenness at least 6 d. This suggested that ROS could promote chlorophyll breakdown and senescence of 'Jinda' chili after harvest.

Keywords: reactive oxygen species, chlorophyll degradation, 'Jinda' chili, cell death-related enzyme

Introduction

The lost greenness and reddening are the apparent sight of chili senescence. Reactive oxygen species (ROS) play an important role in initiation of various physiological disorders and senescence-related cell death process in plants. However, the interference of ROS in regulating reddening and deterioration in chili is still suspicious. The objective of this study was to evaluate the involvement of ROS in hastening chlorophyll catabolic enzymes and senescence of fresh green chili fruit during storage. This research will provide the mechanism for regulating chili senescence as well as the way to intervene in the process.

Methods and Materials



Results and Discussion

Degreening and reddening in chili occurred on day 3 after storage (Fig 1A) coinciding with the elevated ROS levels and chlorophyll degradative enzymes (Fig 2). The increase in ROS during storage could be the result of declining ROS-scavenging enzymes (1,2). Reduced APX, CAT, and SOD all contributed to H_2O_2 and $O_2^{\bullet-}$ accumulations, respectively (Fig 1). ROS promoted chlorophyll degradation as indicated by the decrease in Chl a and b contents (Fig 1) and pericarp reddening as observed by an increase in carotenoid content. Furthermore, the drastic impacts of ROS contributed to cell death as demonstrated by activating caspase-like enzymes which eventually led to DNA damage (Fig 3) (1,2,3).

The role of ROS in activated chili pericarp reddening was demonstrated by the addition of an artificial ROS scavenger, BHT (50 μM) treatment. The treatment retained the greenness and retarded the reddening until the end of storage (Fig 4).

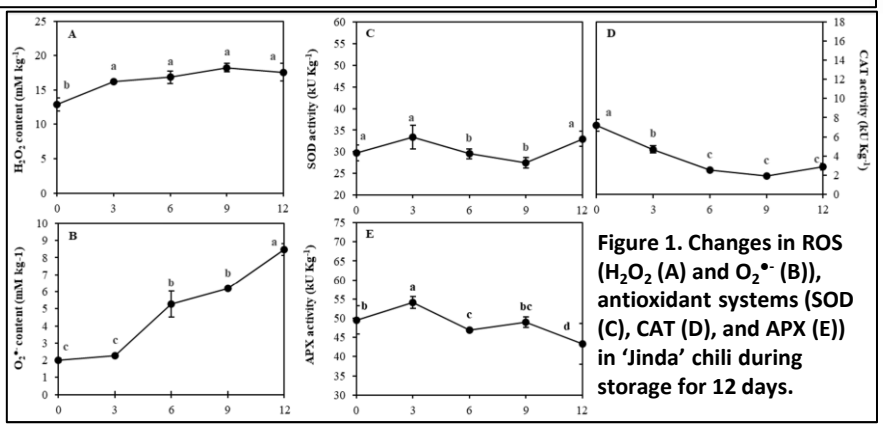


Figure 1. Changes in ROS (H_2O_2 (A) and $O_2^{\bullet-}$ (B)), antioxidant systems (SOD (C), CAT (D), and APX (E)) in 'Jinda' chili during storage for 12 days.

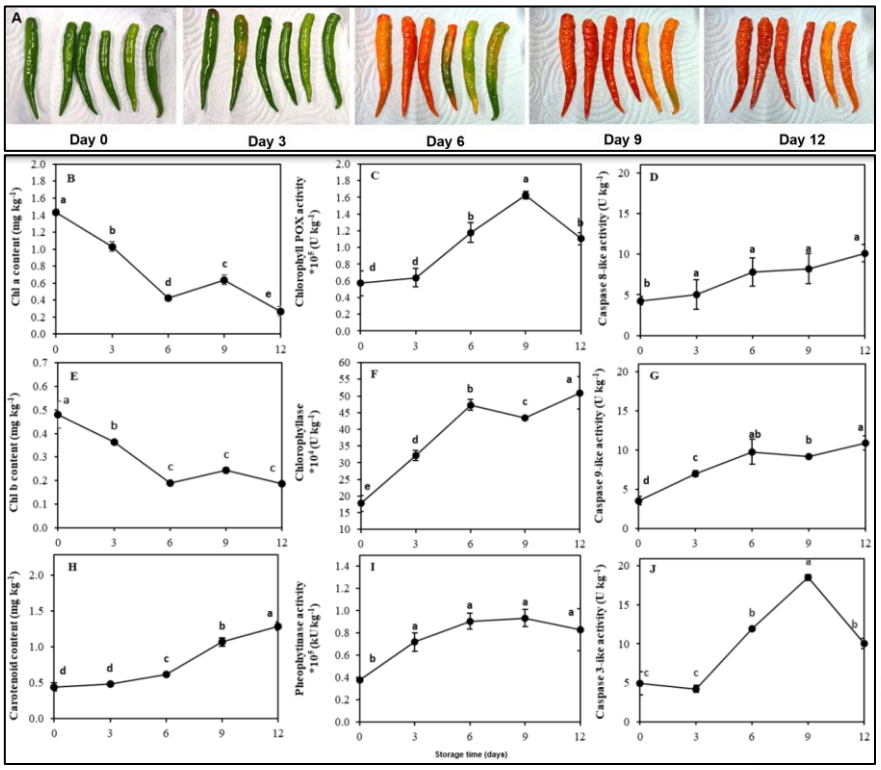


Figure 2. Changes in chlorophyll degradation (A, B, C, E, F, H and I) and cell death-related enzymes (D, E and J) in 'Jinda' chili during storage for 12 days.

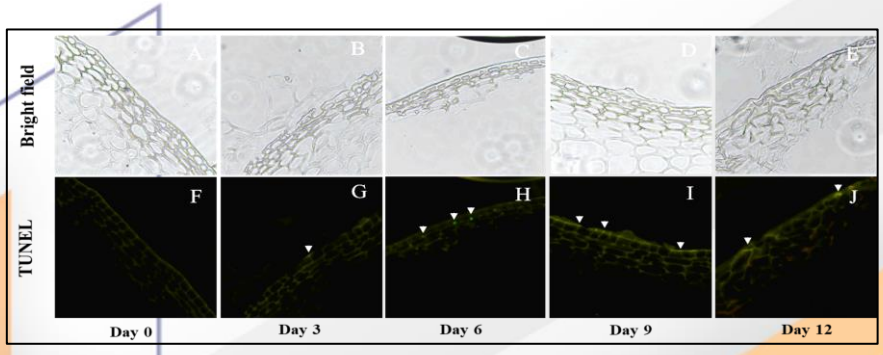


Figure 3. Changes in DNA damage (A-J) of in 'Jinda' chili during storage for 12 days.

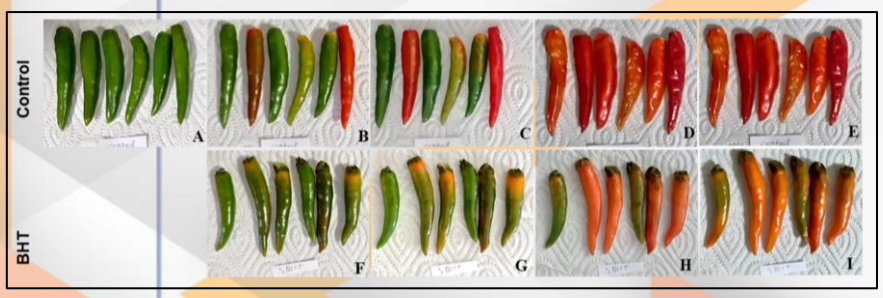


Figure 4. Changes in DNA damage (A-I) of in 'Jinda' chili during storage for 12 days.

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