Melatonin Treatment Delays Postharvest Senescence and Maintains the Organoleptic Quality of 'Newhall' Navel Orange (*Citrus Sinensis* (L.) Osbeck) by Inhibiting Respiration and Enhancing Antioxidant Capacity

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Background Melatonin can improve postharvest quality and strengthen resistance to oxidative stress-induced senescence of many horticultural products(1-8), however, the effects of melatonin on storage quality and physiological senescence of citrus fruit are still unclear.

Methods Commercially matured 'Newhall' navel oranges were immersed into 200 μmol L^{-1} melatonin solution and then stored under ambient conditions for 84 days. The changes of the organoleptic quality and antioxidant system of melatonin-treated fruits were evaluated.

Results Melatonin caused a significant decrease in respiration rate and weight loss rate, and increased in fruit firmness, total soluble solids (TSS), soluble sugar content (SSC), titratable acidity (TA) and Citrus Color Index (CCI) indicating inhibition of fruit quality deterioration (Fig. 1). Melatonin treatment impeded the accumulation of hydrogen peroxide (H_2O_2) and malondialdehyde (MDA), suggesting an inhibition of reactive oxygen species (ROS) burst and oxidative damage (Fig. 2A and B). In addition, the application of melatonin enhanced ROS scavenging capacity by increasing the activity and gene expressions of catalase (CAT), superoxide dismutase (SOD), ascorbate peroxidase (APX), glutathione reductase (GR) and by promoting the accumulation of ascorbate (AsA), and reduced glutathione (GSH) (Fig. 2C to H) and total phenol (data not shown). Moreover, the principal component analysis (PCA) demonstrated melatonin delayed postharvest senescence of orange fruit is associated with the inhibition of postharvest respiration and stimulation of oxidant-defense system (Fig 3).

Conclusion Melatonin markedly delays physiological senescence through a reduction of postharvest respiration and enhancement of the ROS scavenging system including key components of the ASA-GSH cycle (APX, GR, ASA, GSH) and other enzymatic and non-enzymatic antioxidants (CAT, SOD, and total phenol). Meanwhile, quality deterioration of harvested orange fruit was impeded via elevating firmness, flavor substances (soluble sugar and organic acid), and coloration (Fig. 4). These results suggest that MT treatment could be a promising preservation approach for harvested citrus fruit.

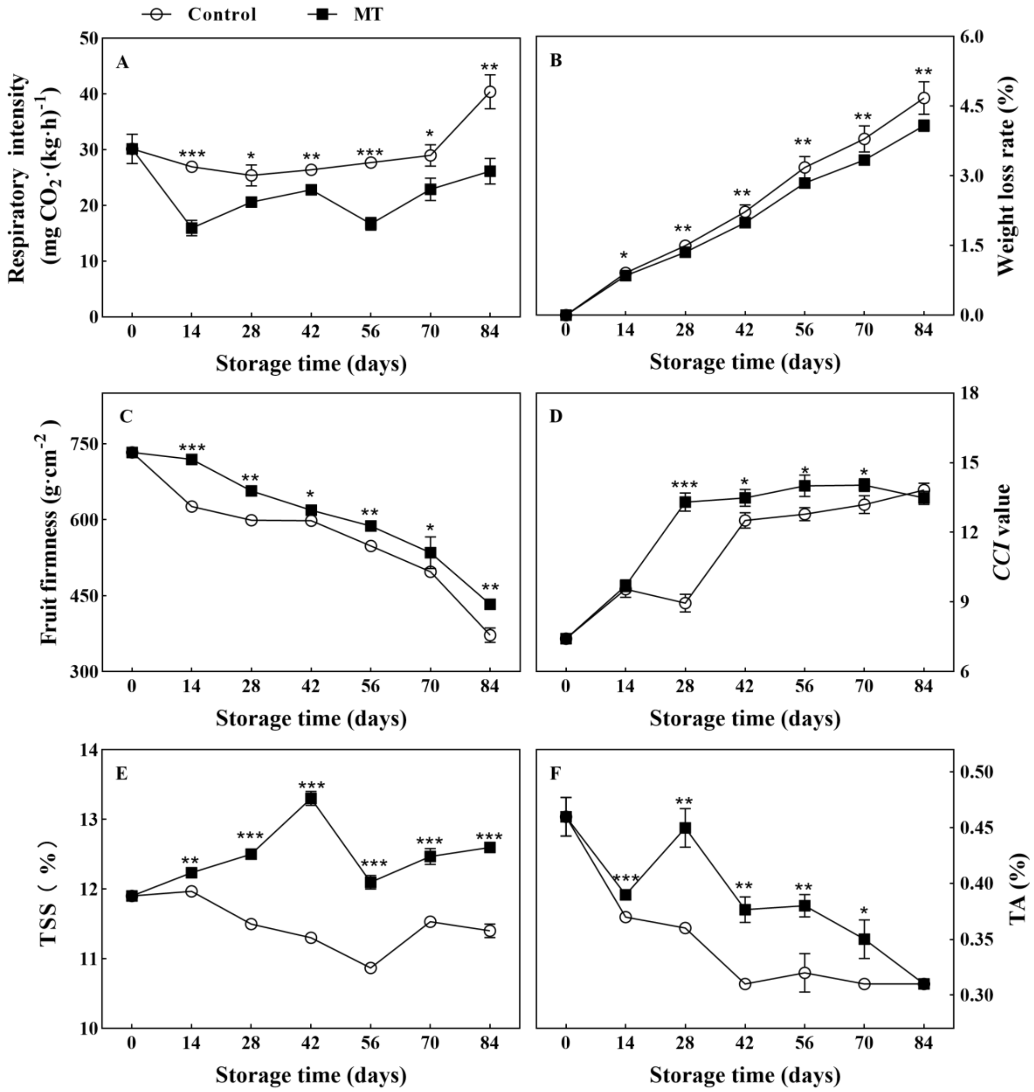

Fig. 1 Changes of respiration intensity (A), weight loss rate (B), fruit firmness (C), citrus color index (CCI, D), Total soluble solids (TSS, E), and Titratable acidity (TA, F) in 'Newhall' navel orange induced by 200 μmol L^{-1} of melatonin.

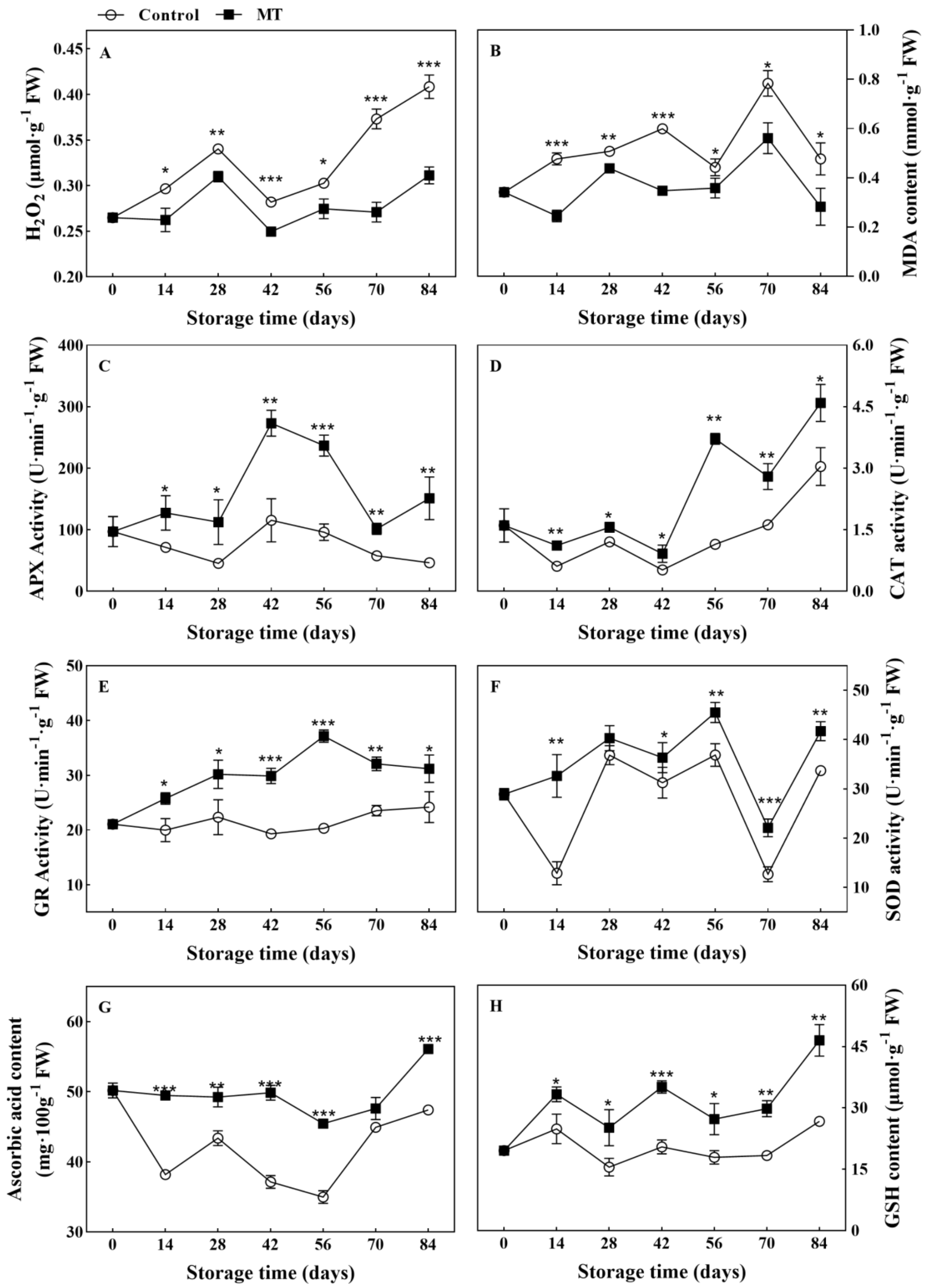

Fig. 2 Changes of H_2O_2 (A) and MDA (B) content, APX (C), CAT (D), GR (E) and SOD (F) enzyme activity, ASA (G) and GSH (H) content in 'Newhall' navel orange induced by 200 μmol L^{-1} of melatonin.

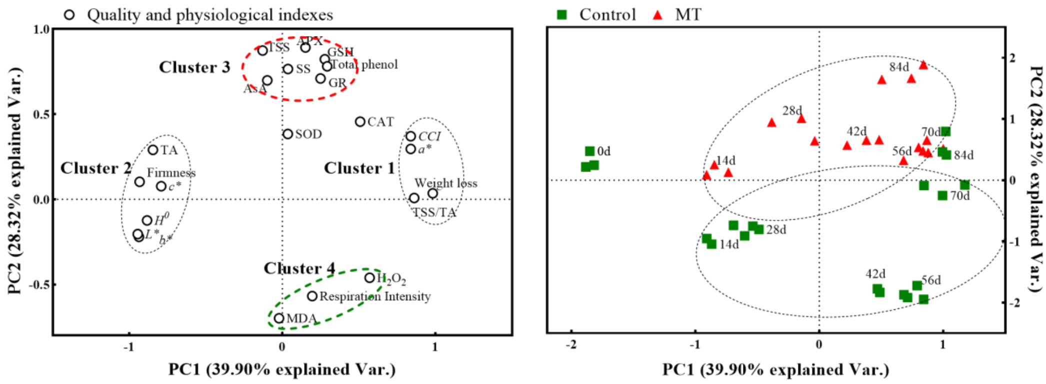

Fig. 3 Distribution of fruit quality and anti-oxidant defense parameters (A) and storage periods of the control and MT treatment (B) based on principal component analysis (PCA).

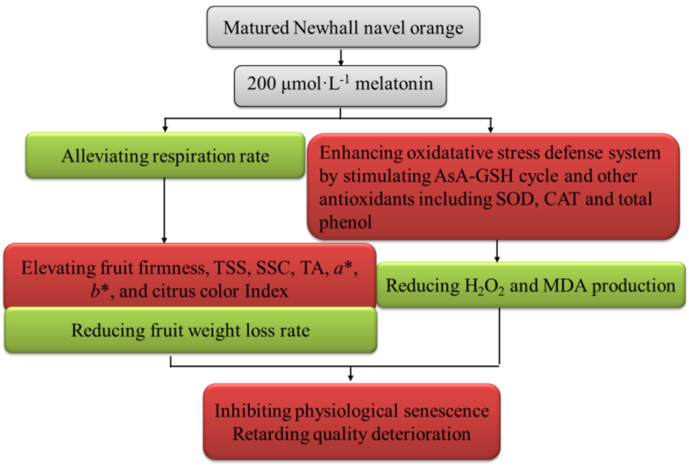

Fig. 4 Schematic of the putative mechanism underlying melatonin delay of quality deterioration through physiological senescence of 'Newhall' navel orange fruit via postharvest respiration reduction and enhancement of the antioxidant defense system.

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