Nitric oxide is involved in melatonin-induced cold tolerance in postharvest litchi fruit

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Introduction

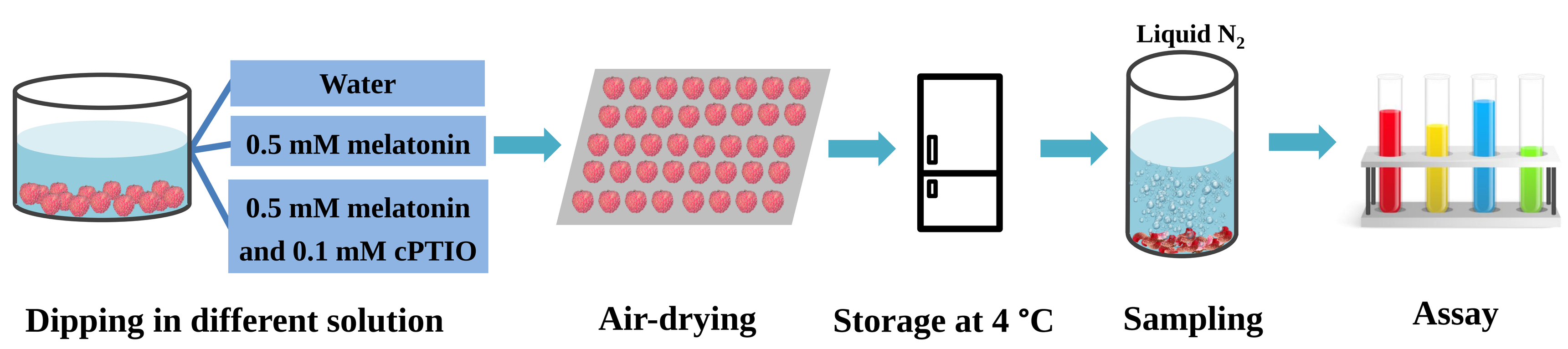
Background

- Litchi fruit is sensitive to low temperatures and vulnerable to chilling injury (CI) when the duration of chilling exposure at 3-5 °C exceeds 2-3 weeks, and CI symptoms become aggravated and show a complete deterioration within 1 d once chilled fruit are transferred to ambient conditions.
- Melatonin, as a natural and environment-friendly compound, has been researched in a wide range of postharvest fruits and vegetables for its prominent efficacy in improving the storability and maintaining the quality of products. Recently, the interaction between melatonin and NO has been examined in a few harvested crops. However, the potential role of NO and its mode of action in melatonin-induced cold tolerance in postharvest litchis has not yet been explored.

Objective

- Exogenous melatonin and cPTIO were employed to treat postharvest litchis and the effect of the interplay between melatonin and NO on cold tolerance in litchi fruit was elucidated by evaluating NO synthesis, cellular redox-related parameters and level of protein *S*-nitrosylation.

Methods



- **Chilling injury severity in fruit during refrigeration**
- **Determination of NO content and synthesis enzymes activities**
- **Determination of cellular redox-related parameters**
- **Determination of protein *S*-nitrosylation levels**

Results

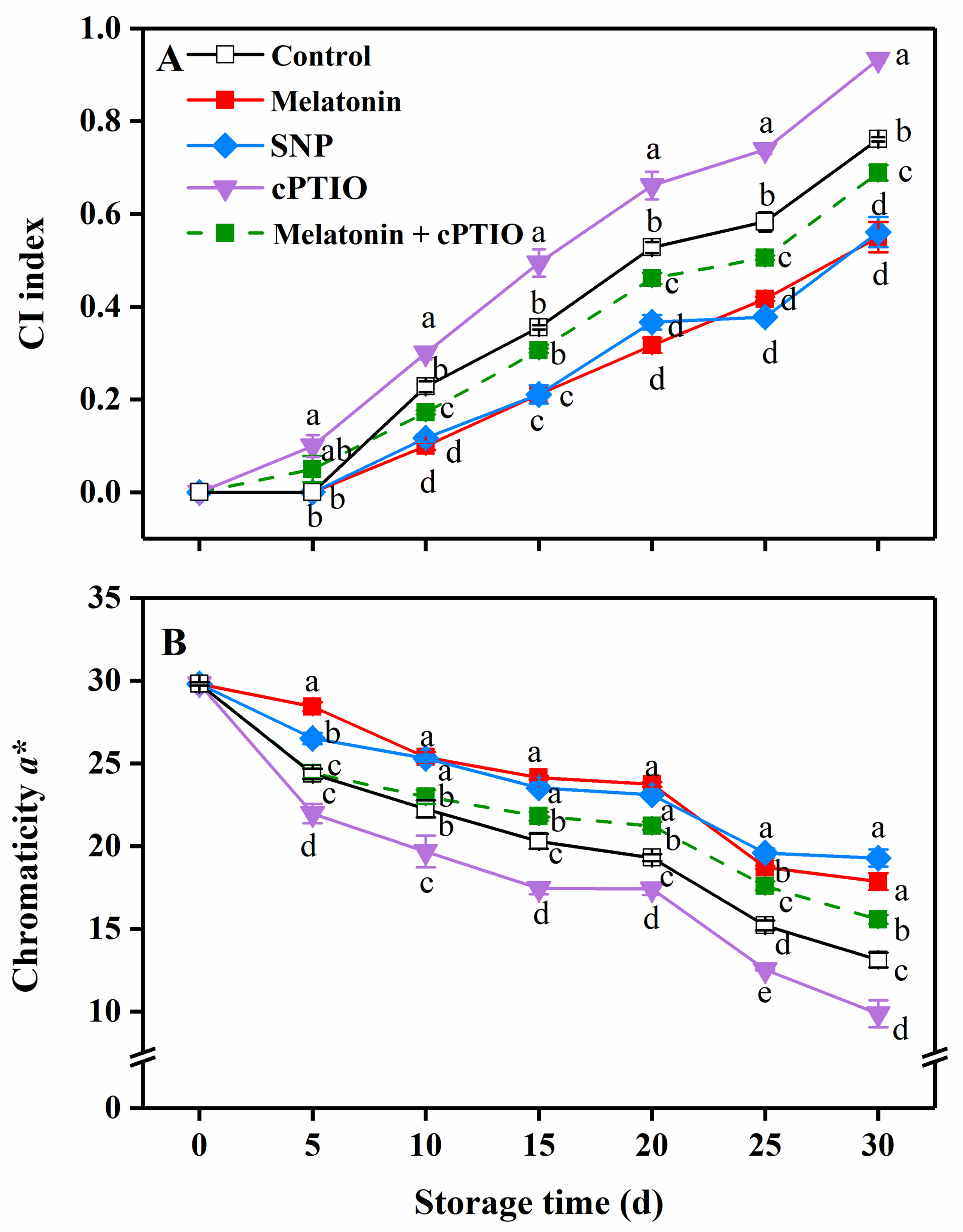


Fig. 1. CI index (A) and chromaticity *a** (B) in litchi (cv. Ziniangxi) fruit during storage of 30 d at 4 °C after treatments with water, 0.5 mM melatonin, 0.1 mM SNP, 0.1 mM cPTIO, and melatonin + cPTIO.

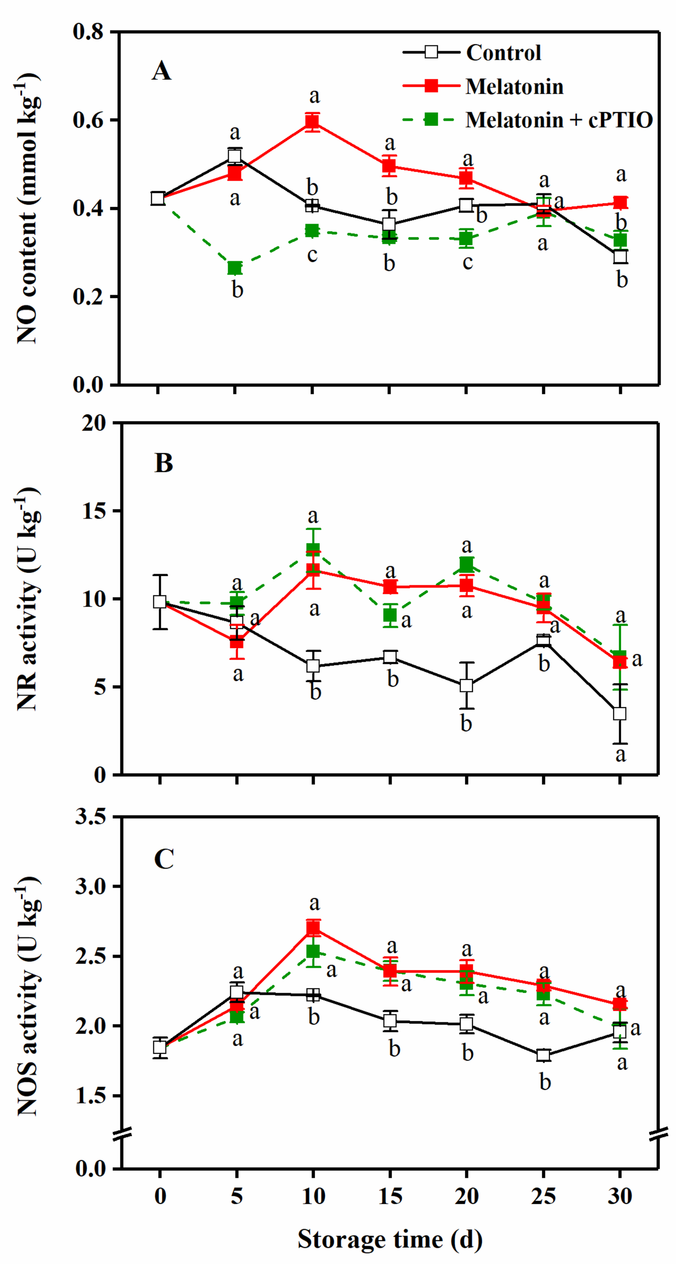


Fig. 2. NO content (A), activities of NR (B) and NOS (C), in litchi (cv. Ziniangxi) fruit during storage of 30 d at 4 °C after treatments with water, melatonin, and melatonin + cPTIO

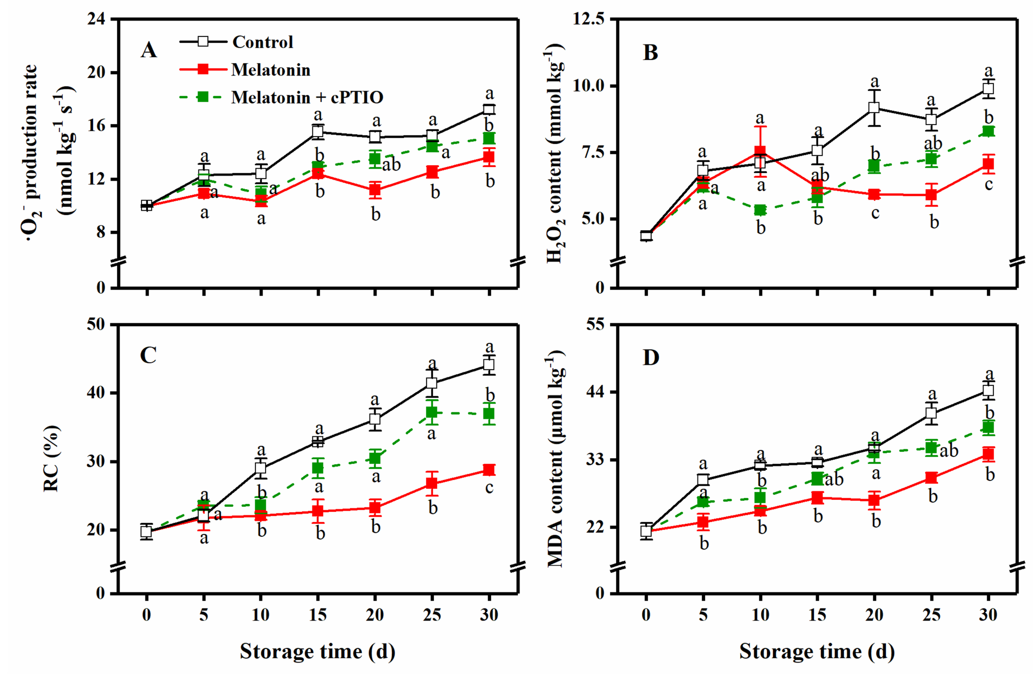


Fig. 3. $\cdot O_2^-$ production rate (A), H_2O_2 content (B), RC (C) and MDA content (D) in litchi (cv. Ziniangxi) fruit during storage of 30 d at 4 °C after treatments with water, melatonin, and melatonin + cPTIO .

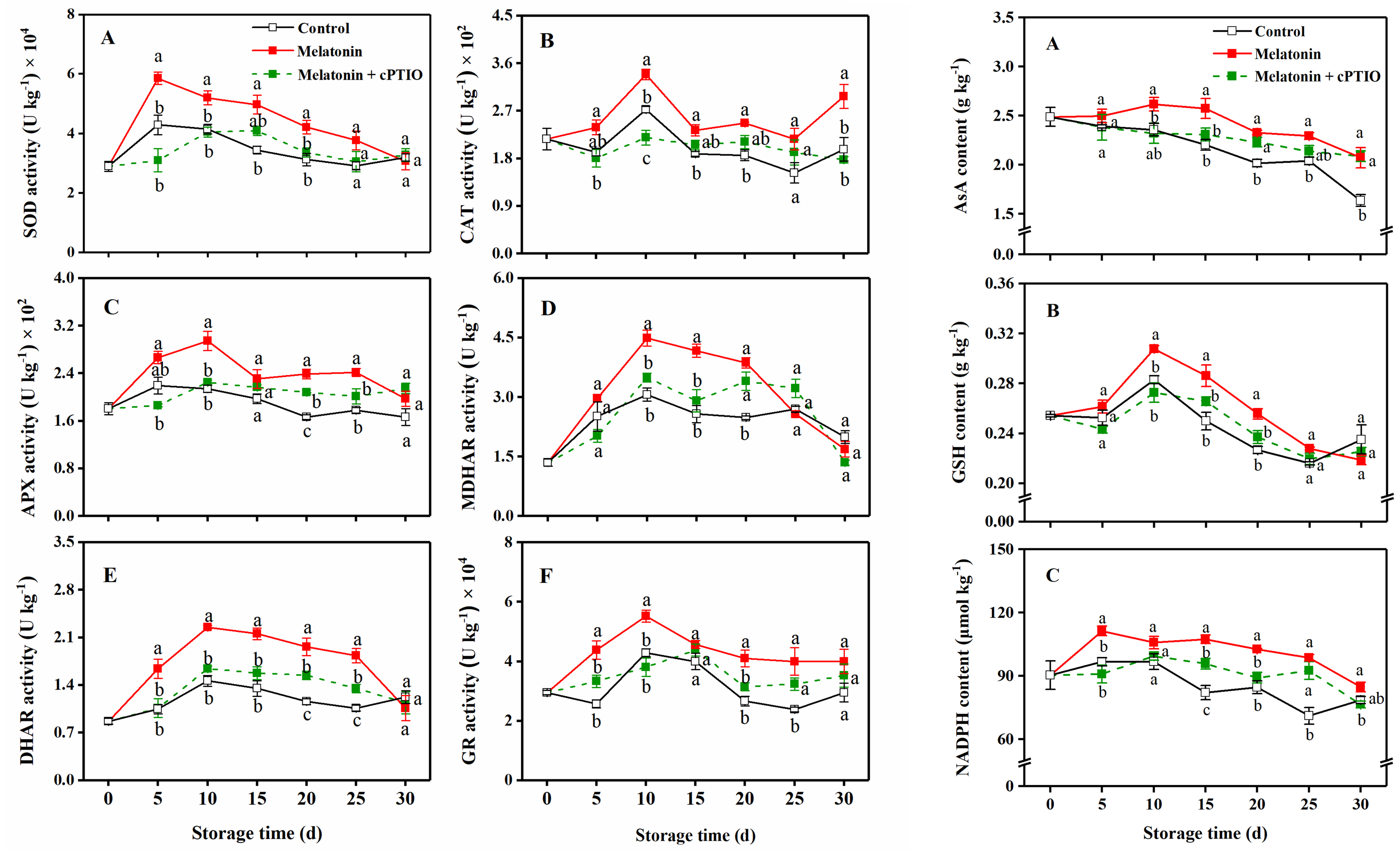


Fig. 4-5. Activities of SOD, CAT, APX, MDHAR, DHAR and GR (4A-F), the contents of AsA, GSH and NADPH (5A-C) in litchi (cv. Ziniangxi) fruit during storage of 30 d at 4 °C after treatments with water, melatonin, and melatonin + cPTIO.

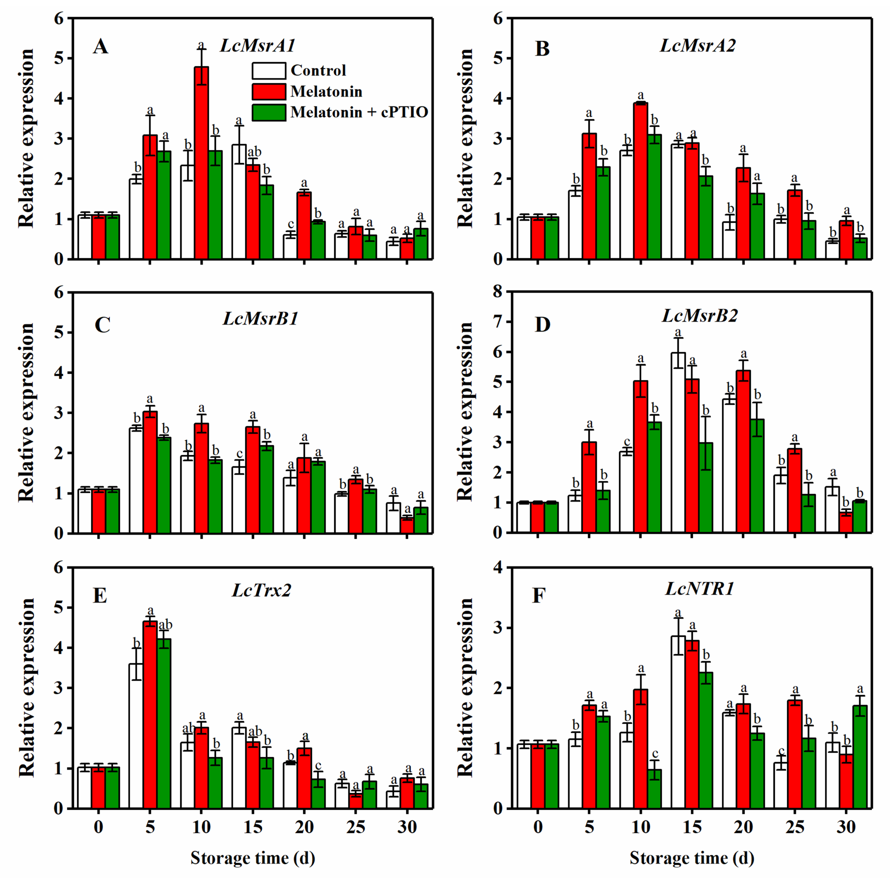


Fig. 6. Relative expression levels of LcMsrA1 (A), LcMsrA2 (B), LcMsrB1 (C), LcMsrB2 (D), LcTrx2 (E) and LcNTR1 (F) in litchi (cv. Ziniangxi) fruit during storage of 30 d at 4 °C after treatments with water, melatonin, and melatonin + cPTIO .

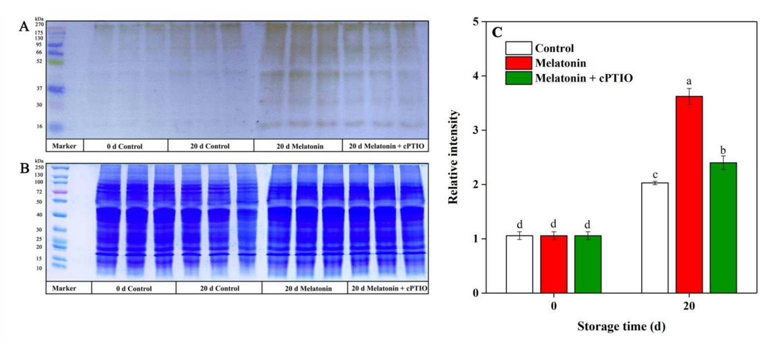


Fig. 7. The protein *S*-nitrosylation level in water, melatonin, and melatonin + cPTIO treated 'Ziniangxi' litchi fruit at 0 and 20 d of storage at 4 °C.

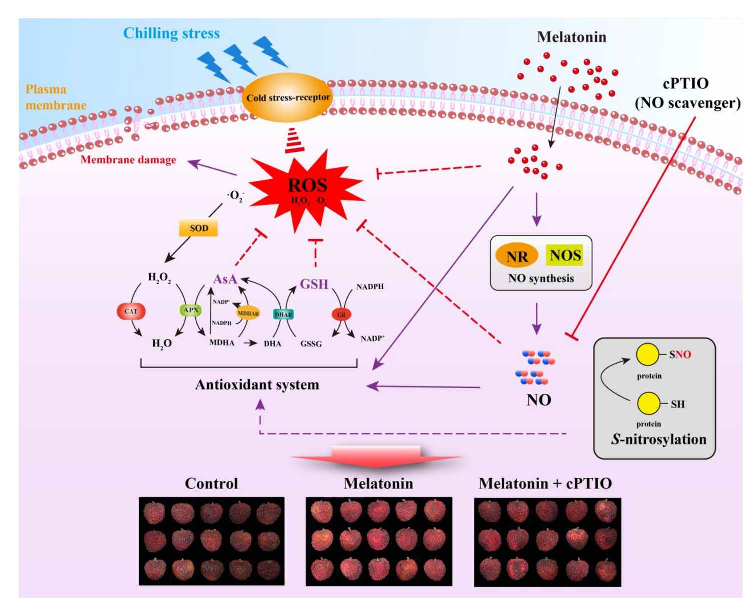


Fig. 8. Schematic overview of proposed model for melatonin-induced cold tolerance via mediation of nitric oxide. → : Stimulatory effect; ⊣ : Inhibitory effect.

Conclusions

- Exogenous melatonin application to litchi fruit appreciably ameliorated the occurrence of CI by strengthening cold tolerance, which could be associated with activation of the antioxidant system and improved repair capacity in oxidatively-injured proteins.
- Endogenous NO could be, at least partly, responsible for melatonin-induced cold tolerance in litchi fruit, which might be involved in the regulation of redox status.
- The sophisticated regulatory mechanism of fruit cold tolerance via a complex interplay between melatonin and NO needs to be further studied.

Acknowledgement

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