Research Article

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Improving blueberry cold storage quality: the effect of preharvest hexanal application on chilling injuries and antioxidant defense mechanisms

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Abstract

Blueberries are vulnerable to chilling injury (CI). This can lead to limited longevity when they are subjected to cold storage conditions. This study investigated the effectiveness of a preharvest spray containing 0.02% hexanal in reducing CI and improving the postharvest storage quality of 'Star' and 'Biloxi' blueberries. The blueberries were stored for a period of 5 weeks at 2 °C and in 90% relative humidity (RH). The findings revealed that the preharvest hexanal spraying of both cultivars delayed senescence by mitigating CI, as evidenced by the bolstering of the antioxidant defense system through increased superoxide dismutase (SOD), ascorbate peroxidase (APX), peroxidase (POD), catalase (CAT), and phenylalanine ammonia lyase (PAL) enzyme activity. The treated fruit also maintained elevated levels of total phenol content (TPC), total flavonoids (TFC), and vitamin C, demonstrating enhanced free radical scavenging capacity (FRSC), while exhibiting reduced polyphenoloxidase (PPO) activity, and reduced malondialdehyde (MDA), and H_2O_2 content in comparison with the control group. The preharvest hexanal treatment also suppressed fruit softening by maintaining greater firmness and higher membrane stability index (MSI) scores, inhibiting the activity of polygalacturonase (PG), pectinmethylesterase (PME), xylanase, and α-amylase, and reducing microbial counts (MC) and incidence of decay (DI) in comparison with the control. Preharvest hexanal treatment also improved the overall storage quality by reducing weight loss, total soluble solids (TSS), pH, and the TSS/acid ratio, while increasing titratable acidity (TA) in comparison with the control during cold storage. The findings suggest that hexanal, as a preharvest application, delays senescence effectively and preserves overall quality by enhancing cold tolerance through antioxidant defense mechanisms in blueberry storage under cold conditions.

Keywords: blueberry; postharvest; hexanal; quality; chilling injury; antioxidant; enzyme

INTRODUCTION

Blueberries (*Vaccinium corymbosum*) play a significant role in both the global fruit trade and nutrition. They are regarded as 'natural health packages' owing to their abundant reservoirs of vitamins, minerals, organic acids, and bioactive compounds, such as polyphenols, flavonoids, ascorbic acid, and anthocyanins, collectively contributing to a diverse spectrum of bioactive substances.[1] The rapid expansion in the global production and consumption of blueberries can be attributed to their multiple health benefits, and distinct color, flavor, and taste, drawing significant attention and interest from scientists, nutritionists, food manufacturers, and consumers.[2] However, blueberries are prone to rapid spoilage due to their thin skin and juicy flesh, especially when stored in ambient conditions, hastening the processes of senescence, physical damage, and microbial contamination, resulting in swift softening, weight loss, and decay, thus limiting their storage to a mere 6–8 days and causing significant financial losses.[3-5]

Various physical and chemical preservation techniques have been explored to address this challenge.[6-11] These technologies can partially extend the lifespan of blueberries but their

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