

Title Effect of postharvest ethylene treatment on carotenoid accumulation and expression of carotenoid biosynthesis-related genes in Satsuma mandarin (*Citrus unshiu* Marc.) fruit fluctuate between temperatures

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Abstract

Previous studies suggest that the effect of ethylene on the carotenoid accumulation in citrus fruit was different in carotenoid species (e.g., beta-cryptoxanthin and violaxanthin). Other studies suggest the effect of ethylene on the accumulation of violaxanthin was different between orange and Satsuma mandarin. However, the mechanism of the difference in the effect of postharvest ethylene treatment on carotenoid accumulation between the treatment temperatures has not been understood. In the present study, the effect of postharvest ethylene treatment at different temperatures (20 and 5°C) on carotenoid accumulation and the expression of the carotenoid biosynthesis-related genes was investigated in the flavedo and juice sacs of Satsuma mandarin (*Citrus unshiu* Marc.). On the basis of the difference in gene expression, the difference in the effect of ethylene on carotenoid accumulation between temperatures could be explained. In flavedo, postharvest ethylene treatment resulted in an increase in carotenoid content at 20°C but not at 5°C. Ethylene stimulated the gene expression of beta-ring hydroxylase (HYb), zeaxanthin epoxidase (ZEP), and 9-cis-epoxycarotenoid dioxygenases (NCEDs) regardless of the temperature. In contrast, ethylene down-regulated the gene expression of phytoene synthase (PSY) and phytoene desaturase (PDS) at 5°C but slightly up-regulated that at 20°C. Thus, the difference in the effect of postharvest ethylene treatment on carotenoid accumulation between temperatures was primarily caused by the temperature-dependent response of genes for PSY and PDS. In juice sacs, the effect of postharvest ethylene treatment on carotenoid accumulation was slight, although ethylene slightly up-regulated the genes for HYb, ZEP, and NCEDs regardless of the temperatures. The results in flavedo and juice sacs suggested that the temperature-independent up-regulation of the genes for HYb, ZEP, and NCEDs by postharvest ethylene treatment were similar in flavedo and juice sacs. In the present study, the mechanism of the difference in the effect of ethylene on carotenoid accumulation between orange and Satsuma mandarin was also discussed on the basis of the present results.