Title GABA metabolism in postharvest stress responses

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Abstract

ã-Aminobutyric acid (GABA) synthesis tends to be regulated in an organ- or tissue-specific manner, and many studies suggest that it accumulates in plants under a variety of stress conditions. However, very little is known about GABA metabolism in fruit during postharvest stresses. The objective of this dissertation study was to determine GABA metabolism in response to postharvest stresses using chilling injury inducing conditions and elevated CO_2 treatments. The dissertation reports studies on the effects of cold storage of tomato, and elevated CO_2 concentrations on strawberry and tomato on patterns of GABA accumulation. Glutamate decarboxylase (GAD) activity, GABA transaminase (GABA-T) activity, and gene expression analysis of enzymes in the GABA shunt were analyzed. The correlation between antioxidant metabolism and GABA metabolism in cold stored tomatoes was also investigated.

In tomato, GABA concentrations increased only in sensitive lines after cold storage at 3 °C for 28 d. Higher GABA concentrations were associated with lower GABA-T activity and lower expression of genes encoding succinic semialdehyde dehydrogenase (SSADH) and succinic semialdehyde reductase (SSR). Hydrogen peroxide (H2O2) accumulated during cold storage, but tolerant lines showed a more efficient antioxidant system as indicated by a decline in H2O2 during ripening at 20 °C, higher activity of ascorbate peroxidase (APX) during cold storage and ripening, higher peroxidase (POX) activity during ripening, and higher gene expression of superoxide dismutase (*SOD*) during cold storage.

GABA concentrations decreased in breaker fruit during storage but increased in red fruit, when treated with 10% CO_2. Greater GABA accumulation in red fruit was associated with higher CO_2 injury in fruit of that maturity stage. GABA concentrations decreased when transferred to air. CO_2 treatment was associated with higher gene expression of *GAD2* and *GAD3* in both stages, but an increase was greater in breaker fruit than red fruit. CO_2 treatment altered GABA degradation as shown by decreased GABA-T activity in both stages, but to greater extent in red fruit, as well as decreased succinic semialdehyde reductase 1 (*SSR1*) gene expression in red fruit, and decreased of *SSR2* expression in both maturity stages.

A study in strawberry cultivars with different tolerance to postharvest treatment with 20% CO_2 showed that CO_2 treatment induced GABA production, but the accumulation was not associated with sensitivity of the fruit to high CO_2 treatment as indicated by fermentation product accumulation.

The results suggest that GABA metabolism in fruit responds differently than in model systems that used intact plant organs and in which accumulation of GABA in response to stress is rapid. In postharvest systems, accumulation is delayed, if it occurs at all. The specific role of GABA in postharvest responses therefore remains uncertain.