

# Chlorogenic acid treatment alleviates the adverse physiological responses of vibration injury in apple fruit through the regulation of energy metabolism

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## Abstract

Apple fruit are susceptible to vibration injury during handling, transportation and postharvest storage. Vibration injury causes the deterioration of fruit quality and results in economic losses. The effects of chlorogenic acid (CGA) treatment on postharvest physiological indicators and energy metabolism of vibration damaged apple fruit stored at  $23 \pm 1$  °C for up to 28 d have been investigated. CGA treatment slowed softening, the decrease of soluble solids content and titratable acidity, reducing weight loss, electrolyte leakage, malondialdehyde accumulation and the respiration rate. CGA treatment also reduced in the rate of ethylene production through the regulation of enzymes that are involved in ethylene biosynthesis. An increase in the levels of adenosine triphosphate and energy charge were observed in apple fruit after CGA treatment. Activities of enzymes involved in energy metabolism including H<sup>+</sup>-adenosine triphosphatase, Ca<sup>2+</sup>-adenosine triphosphatase, succinic dehydrogenase and cytochrome C oxidase were increased by CGA treatment. The collective data indicated that CGA treatment reduced the adverse physiological changes caused by vibration damage in apple fruit. The mechanism of action may in part be related to enhancing the energy status and the activity of enzymes involved in energy metabolism as well as the maintenance of membrane integrity of the fruit. CGA may be used to provide a method to reduce food wastage and economic losses in the production and marketing of apple fruit.