be sensorially similar, although exogenous ethylene tends to shift the profile toward higher glucose, fructose, and quinate and lower sucrose, citrate, and malate.

7.3 Storage conditions and flavor stability

Low-temperature storage modifies sugar and acid metabolism in ways that are partly independent of ethylene. Mitalo et al. (2019) pointed out that kiwifruit can soften and accumulate sugars at 5 °C without detectable ethylene, and these changes occur faster at 5 °C than at 22 °C in ethylene-free air. Mechanistically, cool temperatures between 5 °C and 10 °C accelerate starch degradation and SSC increase even when ethylene perception is blocked by 1-MCP, through the AcCTS1–AcBAM3 pathway (Li et al., 2026). However, low-temperature-ripened fruit remain deficient in ethylene-dependent aroma volatiles, so faster sugar gain does not necessarily preserve the full flavor profile (Mitalo et al., 2019). In hardy kiwifruit, 1 °C delays ripening relative to 5°C, slows starch degradation, but can favor later soluble sugar accumulation while increasing chilling injury risk (Lee et al., 2025).

Controlled-atmosphere storage helps preserve sugar–acid balance chiefly by slowing softening, decay, and acid loss, but the gas composition must stay within a safe range. In 'Jinyan', storage at 1 °C under 5% O_2 + 4% CO_2 delayed losses of firmness, acidity, and vitamin C and reduced decay by 43.7% at 200 days, whereas 2% CO_2 caused abnormal softening (Zhang et al., 2026). In 'Hayward', later harvest maturity improved long-term RA and CA outcomes and slowed acidity decline during storage, showing that storage stability depends partly on preharvest maturity at harvest (Goldberg et al., 2021). For cold-sensitive 'Xuxiang', 1-MCP followed by ethylene alleviated chilling injury better than ethylene alone and maintained fruit quality during 0 °C storage (Liu et al., 2021). In addition to genetic and developmental regulation, sugar–acid balance can be substantially modified by preharvest source–sink management and postharvest ripening conditions (Figure 3).

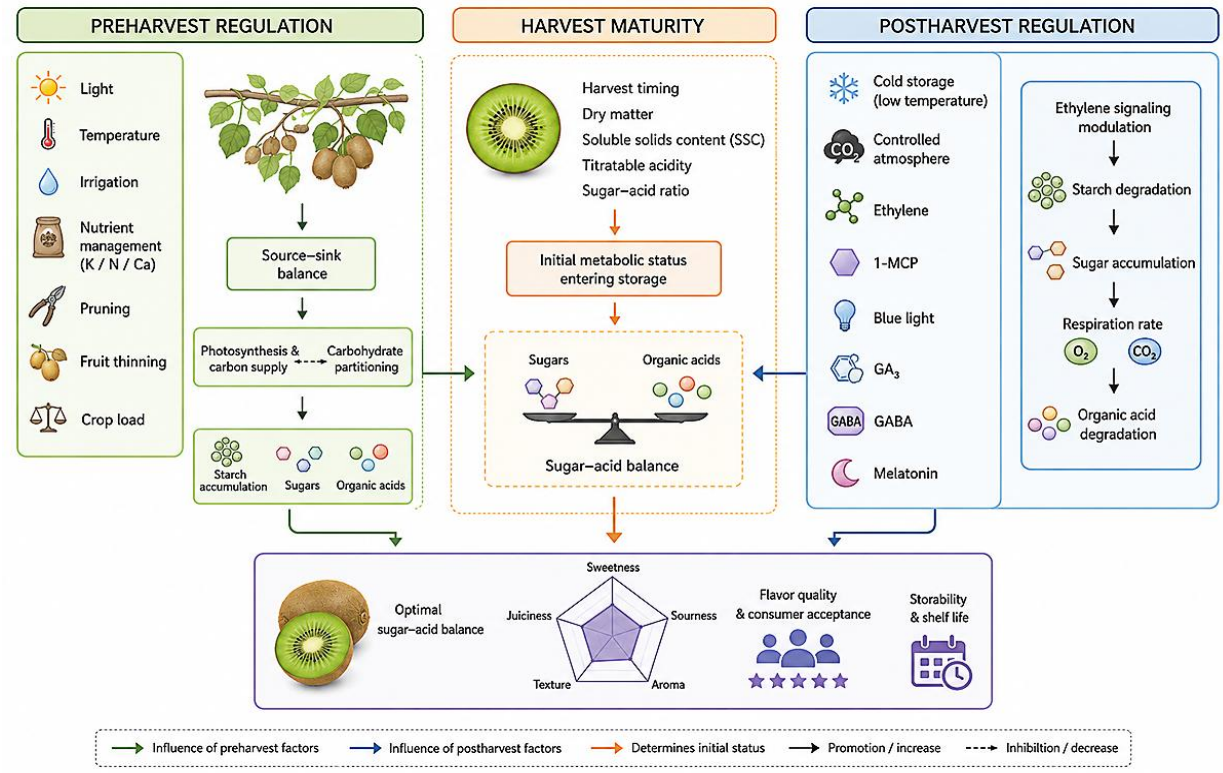


Figure 3 Integrated effects of environmental, cultivation, and postharvest factors on sugar–acid balance and flavor quality in kiwifruit
Image caption: Preharvest factors, including light, temperature, irrigation, nutrient management, pruning, thinning, and crop load, influence photosynthetic carbon supply and source-sink relationships. Harvest maturity determines the metabolic state entering storage, whereas postharvest temperature, atmospheric composition, ethylene-related treatments, light, and other regulators modify starch degradation, sugar accumulation, respiration, and organic acid loss. Their combined effects ultimately determine sugar–acid balance, flavor quality, and storage performance