



Figure 1 The genetic basis and molecular regulation of sweetness and acidity traits in cultivated strawberry (*Fragaria × ananassa*)

## 5 The Impact of Environmental and Cultivation Measures on Sweetness and Acidity Traits

### 5.1 The regulatory roles of light, temperature, and water conditions

Light quantity and quality strongly influence strawberry sugar and acid accumulation, especially in protected cultivation where natural light is limiting. In autumn-spring greenhouses, combining elevated CO<sub>2</sub> with LED supplemental light increased yield by over 50% compared with ambient conditions, while significantly increasing soluble sugar content and decreasing titratable acidity, thereby enhancing perceived sweetness (Tang et al., 2023). More precise chromatic control of LED spectra showed that supplemental light generally raised soluble solids by about 7% and titratable acidity by 27%, with color temperature and illuminance determining the exact balance between sugars and acids and thus flavor intensity (Patel et al., 2023).

Light treatments can also modulate sweetness-acidity traits after harvest. Continuous red LED exposure during cold storage improved total soluble solids and maintained firmness, while reducing weight loss relative to dark storage, indicating better retention of sweetness and texture (Kilic et al., 2021). By contrast, blue light combined with salicylic acid during refrigerated storage stabilized total soluble solids and titratable acidity at relatively low but constant levels, while markedly improving antioxidant capacity and delaying decay, thus conserving an acceptable sugar-acid balance over an extended storage period (Xu et al., 2023).

Temperature and water status interact to shape field sweetness-acidity profiles. Across multiple farms, soluble solids and titratable acidity were both positively associated with the air temperature differential (day-night difference) during ripening, whereas contrasting fertilization and input regimes showed no consistent effect on SSC or TA, suggesting that mesoclimate is a primary driver of basic taste attributes (Li et al., 2024). In greenhouse experiments manipulating irrigation levels, moderate deficit irrigation reduced yield and titratable acidity but increased soluble sugars, the sugar-acid ratio, and water-use efficiency, indicating that carefully controlled water stress can enhance sweetness perception without severely compromising quality (Jiang et al., 2023).