Belle citrus grown under sandy soil conditions, foliar potassium application improved peel color and overall fruit quality; potassium nitrate applied in July or from May to July increased fruit size to more than 65 mm. In Page mandarin, potassium-containing foliar nutrient treatments increased fruit diameter and improved peel color parameters, including L*, a*, and b* values, which were consistent with enhanced visual quality (ValizadehKaji and Mohammaei, 2025). In Fremont mandarin, potassium nitrate application promoted fruit enlargement and improved fruit color and appearance, although most internal quality parameters showed limited changes in this experiment (Ülker and Kamiloğlu, 2021).

Potassium also influences peel development and firmness, both of which are important for fruit transportation performance and resistance to physiological disorders. Jiao et al. (2022) reported that potassium application in a citrus hybrid susceptible to fruit cracking increased the ratio of peel firmness to pulp firmness, enhanced potassium, calcium, and nitrogen accumulation in both peel and pulp tissues, and alleviated fruit cracking. The same study system and related citrus research indicate that sufficient potassium supply promotes peel tissue development and structural strengthening, thereby reducing the risk of fruit cracking (Jiao et al., 2022; Shrestha et al., 2025). In Sugar Belle citrus, foliar potassium application before autumn increased peel thickness to approximately 1.15 times that of the control, while combined potassium and boron application improved peel puncture resistance (Shrestha et al., 2025). In sweet lime, foliar application of KNO_3 increased fruit firmness and juice content, which is consistent with the role of potassium in maintaining cell membrane stability and regulating vacuolar osmotic balance (Khan et al., 2025).

However, the effects of potassium on fruit quality are not always consistent. In ‘Salustiana’ orange, high potassium supply reduced magnesium and calcium accumulation in the flavedo but did not significantly alter peel thickness, external color, firmness, total soluble solids content, or acidity (Manzi et al., 2026).

5.2 Influence on internal quality traits

The most consistent effects of potassium on improving citrus internal quality are mainly reflected in increased total soluble solids (TSS), enhanced soluble sugar accumulation, and improved sugar–acid balance. In Newhall navel orange, an appropriate fruit potassium concentration (approximately 1.5%) promoted sugar accumulation and improved fruit quality, with both field and pot experiments directly demonstrating increased TSS after potassium application (Wu et al., 2024). In Valencia orange, the application of 0.5 kg nitrogen fertilizer and 0.9 kg potassium fertilizer per tree resulted in the highest TSS and TSS/TA ratio, whereas increasing potassium application rates further tended to increase juice acidity (Nguyen and Tai, 2020).

A meta-analysis of 92 studies conducted by Xu et al. (2024) showed that optimized fertilization with an appropriate increase in K_2O input increased fruit TSS by 5.9%, total sugar content by 8.6%, reduced total acidity by 3.4%, and increased the TSS/TA ratio by 14.0%. However, it should be noted that excessive potassium application may negatively affect internal fruit quality in some production systems by increasing acidity and reducing the sugar–acid ratio (Shrestha et al., 2025).

Studies have shown that potassium can improve vitamin C content and influence secondary metabolic processes, although these responses are more complex than changes in TSS. In Newhall orange, combined application of potassium fertilizer and organic fertilizer not only increased TSS and the sugar–acid ratio but also promoted vitamin C accumulation (Wen et al., 2021). In sweet lime, lower concentrations of KNO_3 increased vitamin C content, which may be related to the regulatory effects of potassium on sugar metabolism and ascorbic acid biosynthesis (Khan et al., 2025).

Potassium also alters metabolite composition in citrus peel and pulp, enhancing amino acid biosynthesis in peel tissues and glycoside accumulation in pulp tissues. Jiao et al. (2022) used the fruit-cracking-susceptible citrus hybrid ‘Ehime Kashi No. 34’ as the experimental material and evaluated three potassium levels. The results showed that potassium treatments increased K, N, and Ca concentrations in both peel and pulp, while improving the peel-to-pulp firmness ratio, photosynthetic rate, and stomatal conductance. Metabolomic analysis identified 59