

contrast, albino or color-variant cultivars such as “Baie No.1”, “Huangjinya”, and “Zijuan” often display lighter, bright yellow, or darker tones due to differences in pigment composition (Shan et al., 2023; Zeng et al., 2024). Among them, albino cultivars show lighter and brighter color because of reduced chlorophyll, whereas purple cultivars may exhibit darker overall color and some degree of bitterness and astringency due to anthocyanin accumulation (Zeng et al., 2024).

Uniformity reflects sprouting consistency and processing adaptability and is an important component of appearance quality. Clonal elite cultivars such as Longjing 43 and some promoted cultivars, due to their high genetic consistency and uniform sprouting, are conducive to standardized harvesting and raw material grading, thereby improving the uniformity of the finished tea. By contrast, population varieties and some highly heterogeneous materials tend to produce greater raw material variation because of inconsistent sprouting, which affects the final visual quality (Yu et al., 2023). Therefore, cultivar selection plays a fundamental role in the formation of Longjing tea appearance quality, influencing the entire process from fresh leaf development to harvest grading and final processing.

#### **4.2 Differences in sensory quality**

Aroma and taste are the most critical sensory dimensions for distinguishing different Longjing tea cultivars. Because cultivars differ in volatile precursors, non-volatile taste compounds, and processing response patterns, the finished teas show different aroma types, freshness, bitterness–astringency intensity, and aftertaste characteristics (Yu et al., 2023; Teng et al., 2024). In general, traditional population varieties, with their more complex metabolic background, tend to produce richer bean-like and chestnut-like aromas with some floral nuances, resulting in more variable and regionally distinctive aroma styles. In contrast, Longjing 43 is mainly characterized by a more balanced fresh–chestnut aroma, a more elegant aroma profile, and better stability, giving it a strong advantage in standardized processing (Yan et al., 2025). Studies on different aroma styles of Longjing tea have shown that when classified into tender-aroma, fresh-aroma, or high-aroma types, their volatile profiles differ markedly, with systematic changes in the types and contents of alcohols, aldehydes, terpenes, and heterocyclic compounds. For example, in bean-aroma and fresh-aroma Longjing teas, geraniol and (E,E)-2,4-heptadienal are important contributors to bean-like aroma, whereas hexanal-d and heptanal-d are more associated with fresh green notes (Ao et al., 2025). This indicates that aroma differences among cultivars are reflected not merely in intensity but more importantly in characteristic aroma combinations and relative proportions.

Among special cultivars, the albino cultivar “Baie No.1” exhibits a different aroma formation pathway from ordinary green-leaf cultivars. Studies have shown that during the early stages of processing, it tends to accumulate more fresh and floral volatile compounds, while during the later frying and aroma-enhancing stages, it gradually develops an aroma framework dominated by pyrazines associated with chestnut-like notes (Teng et al., 2024; Yan et al., 2025). Therefore, even when processed into Longjing tea, different cultivars may express different aroma styles, such as “floral-dominant,” “bean-aroma prominent,” or “chestnut-aroma pronounced,” which directly affects product style classification and market positioning. Taste differences are likewise clearly cultivar-dependent. Variations among cultivars in amino acids, flavonoids, alkaloids, lipids, and peptides systematically influence freshness, bitterness–astringency, mellowness, and aftertaste potential of the tea liquor (Yu et al., 2023; Yan et al., 2025). Cultivars with higher amino acid content usually exhibit stronger freshness and lower stimulation, making them suitable for producing a fresh and balanced taste profile, whereas cultivars with higher levels of tea polyphenols, complex catechins, and flavonol glycosides often show stronger taste, more obvious astringency, but also a more defined body and longer aftertaste (Yu et al., 2023; Li et al., 2025).

Taking Longjing 43 as an example, it usually contains higher levels of theanine and glutamine, along with greater flavonoid accumulation, and therefore often produces tea with better freshness and balance. By contrast, albino or special cultivars such as Baie No.1 generally accumulate more glutamic acid and glutamine but relatively lower levels of bitterness-related alkaloids such as caffeine and theobromine, resulting in a sweeter, fresher, milder, and less stimulating taste (Teng et al., 2024). In addition, Longjing 43 and population varieties differ not only in small-molecule metabolites but also in peptide composition. Studies have shown that population varieties contain