

analyzes the patterns of quality formation and preservation, screens harvest and processing conditions suitable for the production of high-quality raw materials, and provides a reference for optimizing field harvest decisions, improving post-harvest processing parameters, enhancing product quality consistency, and promoting the standardized development of the Hangbaiju industry.

2 Quality Evaluation Indicator System for Hangbaiju

2.1 Appearance and commercial quality indicators of Hangbaiju

Appearance and commercial quality are the most direct indicators in the primary grading of Hangbaiju, because consumers and traders usually judge flower products first by inflorescence integrity, size, color, and external uniformity. Chrysanthemum flower color and luster are recognized consumer-facing quality traits, while petal color and shape also affect preference and market acceptance (Xu et al., 2022a; Wei et al., 2024). At the same time, appearance alone is not a reliable proxy for intrinsic quality, because different quality grades may show no obvious difference in smell or visible traits, and market practices such as sulfur fumigation can artificially improve appearance while reducing antioxidant activity and bioactive constituents (Wei et al., 2024).

For Hangbaiju-related materials, inflorescence morphology has practical grading value when linked with chemical markers. In Fubaiju, a subvariety introduced from Hangbaiju, inflorescence diameter was negatively correlated with chlorogenic acid and 3,5-O-dicaffeoylquinic acid, and first-grade samples had significantly smaller diameters and higher polyphenol contents (Yang et al., 2025). Studies using hyperspectral imaging further show that exterior morphology can be fused with spectral information to predict total flavonoids and chlorogenic acids with high accuracy, supporting the use of image-based appearance indexes as rapid commercial evaluation tools rather than purely subjective observations (Wei et al., 2024).

2.2 Active components and physicochemical indicators of Hangbaiju

Active components and physicochemical indexes are the core of scientific Hangbaiju quality evaluation, because the nutritive and commercial values of chrysanthemum tea depend directly on phytochemical composition. Flavones and caffeoylquinic acids are the main active ingredients of Hangbaiju and are explicitly identified as important indicators for evaluating its quality (Lu et al., 2024). Across chrysanthemum cultivars, chlorogenic acid, luteolin, apigenin-7-glucoside, cryptochlorogenic acid, and isochlorogenic acid C contribute strongly to varietal discrimination, while spectrum-effect analysis has further identified chlorogenic acid, 3,5-O-dicaffeoylquinic acid, 4,5-O-dicaffeoylquinic acid, and kaempferol-3-O-rutinoside as candidate Q-markers for quality evaluation (Ouyang et al., 2022; Lu et al., 2022).

The physicochemical indicator system should therefore include total flavonoids, total phenolics, chlorogenic acid and related CQA derivatives, moisture-related drying sufficiency, antioxidant activity, and selected nutritional indexes such as amino acids, soluble sugars, and vitamin C. Developmental studies in Hangbaiju showed that total flavonoids were higher at S1-S2 and total polyphenols peaked at S2, while other chrysanthemum studies found that flavonoid and chlorogenic acid contents were highest at the bud stage or between the bud and young flower stages (Lu et al., 2024). Drying also reshapes these indexes: oven drying at suitable temperatures, microwave-hot air drying, pulsed vacuum drying, and infrared-assisted drying each improved retention of different phenolics or antioxidant properties, showing that physicochemical evaluation must be tied to post-harvest processing conditions rather than measured as a fixed inherent trait (Wang et al., 2019; Sun et al., 2021; Xu et al., 2022a).

2.3 Sensory quality and safety indicators of Hangbaiju

Sensory quality and safety indicators form the third essential dimension of Hangbaiju evaluation because chrysanthemum is both a medicinal and edible material used in tea and food applications (Xu et al., 2022a). Sensory quality includes aroma, taste, color stability, and overall acceptance after processing. Different drying strategies dramatically change aroma profiles, and infrared-hot air drying produced the highest volatile concentration, while kill-green pretreatment with high-humidity air impingement improved color and retained more phenolics, amino acids, volatile compounds, and higher sensory acceptance than steam kill-green (Xu et al., 2024).