information loop that enables whole-process supervision and consumer participation in traceability (Shi et al., 2020).

## 5 Quality Evaluation and Key Control Indicators of Hangzhou White Chrysanthemum

### 5.1 Appearance traits and basic quality indicators

The quality evaluation of Hangzhou White Chrysanthemum should begin with appearance traits and basic physicochemical indicators, because market grading and authenticity judgment still rely first on visible morphology and then on measurable quality parameters. In chrysanthemum, inflorescence diameter is an important classification factor, and smaller flower heads can contain higher chlorogenic acid and 3,5-O-dicaffeoylquinic acid, which means appearance is not only a commercial trait but also linked to medicinal quality. The same study showed that first-grade material had smaller diameters and higher polyphenol content, confirming that flower-head size can serve as a practical grading index when combined with chemistry rather than used alone (Yang et al., 2025). Chrysanthemum evaluation studies more broadly show that objective phenotyping can extract traits such as color coverage, saturation, visual uniformity, flowering efficiency, and plant morphology, and that these visible traits explain much of varietal differentiation (Sun et al., 2025). For production-base traceability, this means the recorded appearance indices of Hangzhou White Chrysanthemum should include flower-head diameter, uniformity, color, integrity, cleanliness, and batch consistency at harvest and after drying.

Basic quality indicators should then verify whether the external appearance corresponds to acceptable internal quality. For Hangzhou white chrysanthemum standard decoction, useful evaluation indices include traits, relative density, pH, extraction ratio, transfer rate, and fingerprint similarity, and these parameters showed good precision, stability, and repeatability in standardized testing. In that study, the standard decoction was a clear yellow-brown solution with relative density of 1.007~1.011, pH of 5.37~5.56, and an average extraction ratio of 23.6%, which illustrates how decoction-specific physicochemical values may inform operational acceptance ranges; these values should not be used directly as quality limits for dried flower heads. Tea-oriented chrysanthemum quality work also uses moisture, water extract, total ash, water-soluble ash, acid-insoluble ash, crude fiber, and microbial counts as routine indicators, and one snow-white chrysanthemum product met packaged dry-tea standards on these measures (Keliat et al., 2026). Because harvest time, origin, and nutrition affect inflorescence diameter and other visible traits, appearance records should always be linked with batch-based analytical results instead of being treated as independent evidence of quality (Yuan et al., 2022).

### 5.2 Functional components and safety quality indicators

The core functional quality of Hangzhou White Chrysanthemum is determined by its flavonoids, phenolic acids, and related secondary metabolites, which are repeatedly identified as the main active constituents of *Chrysanthemum morifolium* (Miao et al., 2026). The Chinese Pharmacopoeia specifies chlorogenic acid, luteolin-7-O-glucoside, and 3,5-O-dicaffeoylquinic acid as key components for Chrysanthemi Flos, and these compounds are also the main ingredients used in recent grading and Q-marker studies. Chromatogram-effect and spectrum-effect approaches further show that quality evaluation should not depend only on origin or processing reputation, because bioactive ingredients and their antioxidant associations provide a more direct basis for quality control (Yuan et al., 2022). Across chrysanthemum materials, chlorogenic acid, 3,5-dicaffeoylquinic acid, and luteolin-7-O-glucoside are strongly associated with antioxidant or protective activity, supporting their use as key functional indicators in Hangzhou White Chrysanthemum traceability files.

Functional quality also varies with origin, cultivation conditions, and process choices, so the traceability system should capture these sources of variation together with the analytical results. Hangbaiju from Tongxiang contained higher levels of rutin, chlorogenic acid, and apigenin-7-O-glucoside, and soil mineral elements were positively correlated with some of these differential metabolites, showing that geographical environment directly shapes medicinal quality (Long et al., 2023). Stable isotope, mineral-element, and fused NIR-ICP-MS models classified chrysanthemum origin with very high accuracy, making origin authentication itself a safety and authenticity indicator for premium regional material (Yao et al., 2023; Li and Wang, 2026). Cultivation and processing further alter bioactive profiles: hydroponic culture increased total flavonoids and chlorogenic acid,