record logistics information, storage and transfer events, retailer identity, sales time, quantities, and prices, while supervision bodies should record inspection, testing, certification, and enforcement information and validate whether products meet the relevant standards before and during market circulation.

2.3 Design of the whole-process quality traceability procedure

The whole-process quality traceability procedure for Hangzhou White Chrysanthemum should be designed as an end-to-end chain that covers input supply, field production, harvesting, processing, storage, distribution, sales, and supervision. Existing research suggests that an effective procedure should first map the supply-chain process and identify where data are generated, in what format, and by which actor; it should then specify the technologies used for data capture and analysis; and finally ensure that useful traceability information can be communicated to downstream users and consumers (Latino et al., 2022). For green production bases, the front end of the procedure must begin before harvest rather than at harvest, because field operations such as pesticide, fertilizer, and water management are part of the quality and sustainability record that downstream actors and consumers increasingly expect to access (Moysiadis et al., 2023).

Operationally, each production batch of Hangzhou White Chrysanthemum should be assigned a unique identification code that accompanies the product through all subsequent links, so that incoming, transformed, and outgoing batches remain associated across the chain. Data collection should combine manual confirmation with IoT-assisted acquisition, such as sensors, scanners, QR codes, RFID, cameras, or mobile terminals, because these tools support real-time monitoring, reduce recording errors, and improve continuity of information flow (Lin et al., 2020). At the storage and computing level, a permissioned or alliance-chain architecture is well suited to this application because agri-food traceability usually involves a defined set of organizations that need secure sharing, internal supervision, and immutable transaction records without relying on a single centralized database (Prashar et al., 2020). After data from each link are uploaded and associated with the batch code, retailers should disclose the relevant traceability information to consumers, while regulators and certification bodies retain authority to inspect records, verify authenticity, locate problematic batches rapidly, and initiate accountability or recall actions when necessary.

3 Quality Traceability in the Green Cultivation Process of Hangzhou White Chrysanthemum

3.1 Production base environment and seedling source information

Traceability in Hangzhou White Chrysanthemum cultivation should begin with production-base environmental information, because chrysanthemum quality varies significantly with geographical origin and growing environment (Figure 1) (Li and Wang, 2026). Studies of Hangbaiju show that key pharmacodynamic compounds, including rutin and chlorogenic acid, were most abundant in samples from Tongxiang, and soil mineral elements were positively correlated with several differential metabolites, indicating that origin and soil conditions directly shape medicinal quality (Long et al., 2023). More broadly, chrysanthemum origin can be authenticated with high accuracy using mineral-element, stable-isotope, or fused NIR-ICP-MS signatures, which shows that environmental and edaphic differences leave measurable chemical fingerprints that are suitable for traceability verification (Yao et al., 2023). Accordingly, the traceability record for each production base should include location, plot identity, altitude if relevant, soil type, pH, organic matter, available nitrogen, phosphorus, and potassium, irrigation-water source, and surrounding ecological conditions, because these variables are repeatedly treated as foundational to chrysanthemum yield and quality formation (Zhang et al., 2023).

Environmental traceability should also include the source and health status of seedlings, because seedling origin is the first biological node in the production chain and directly affects the uniformity and reliability of later quality records (He and Shi, 2021). Hangzhou White Chrysanthemum can be propagated through virus-free rapid propagation, in which infected buds are detoxified and cultured to obtain virus-free callus and clustered buds, and this technology reduces production cost while accelerating propagation, making it highly suitable for standardized base management. Related chrysanthemum studies also specify that healthy, disease-free cuttings and equally sized seedlings are used for uniform field establishment, while self-cultivated seedling cuttings and owned stock plants provide clear provenance for planting materials. Therefore, traceability files should record cultivar name,