However, the rapid expansion of the *G. lucidum* spore powder market has also exposed prominent constraints in production efficiency, raw material stability, and product consistency. Natural resource limitations, strict growth requirements, and difficulty maintaining stable yield and quality across cultivation batches still restrict large-scale development and utilization. At the cultivar level, current spore-oriented production remains overly dependent on a limited number of strains; in particular, "Longzhi No.1" has been widely used for spore production, yet its poor resistance to competing microorganisms has reduced its suitability for industrial cultivation, creating an urgent need for new varieties with both high spore yield and stronger resistance (Tang et al., 2023). Even after raw materials are obtained, quality variation remains substantial. Commercial and regional comparisons show marked differences in triterpenoid content, physicochemical properties, antioxidant activity, enzyme inhibition, and overall chemical composition among different sources, years, and producing areas, which directly affects the medicinal value, functional performance, and market credibility of downstream products (Yeung et al., 2022; Zhang et al., 2023; Li et al., 2026). These findings indicate that production of *G. lucidum* spore powder still lacks a sufficiently integrated technical system linking strain selection, cultivation management, harvest timing, wall-breaking or wall-removal processing, and quality evaluation.

In addition to inconsistency, authenticity and safety risks remain major obstacles to standardization. Adulteration is a documented problem in the market, with dyed starch being deliberately mixed into *G. lucidum* spore powder to reduce production costs, prompting the development of rapid near-infrared and chemometric methods for authenticity identification and adulteration quantification (Shi et al., 2022). Fraudulent labeling of geographic origin is also a concern because active ingredient levels and commercial value vary significantly by origin, while cultivation region, stage, substrate, and cultivar can all affect elemental, isotopic, and chemical profiles; isotope-based traceability models have therefore been proposed as quality control tools with high classification accuracy (Wadood et al., 2023; Zhang et al., 2023). Safety control must also address contaminants introduced during processing and commercialization. Excessive phthalate plasticizers have been found in *G. lucidum* spore oil, highlighting process-related quality risks, while population exposure assessments for potentially toxic elements and the need for microbial and heavy-metal limits are consistent with broader calls for stronger safety assurance across the industrial chain (Qi et al., 2025). At the same time, manufacturing technology itself influences efficacy: wall-removed spore powder contains higher polysaccharide and triterpenoid levels and shows stronger antitumor effects than wall-broken powder, while process optimization based on industrial data can raise critical quality-property performance for moisture, fineness, crude polysaccharides, and total triterpenes to acceptable process capability levels (Shi et al., 2021; Zhong et al., 2023).

This study explores the construction pathway of an efficient production and quality control technology system for *Ganoderma lucidum* spore powder. It systematically analyzes key technical aspects, including elite strain selection, efficient cultivation, standardized harvesting, optimized sporoderm-breaking or sporoderm-removal processing, authenticity identification, quality traceability, and multi-indicator comprehensive evaluation. Existing standard systems have provided a certain foundation for the standardized development of the *G. lucidum* spore powder industry. However, previous studies have shown that current standard limits alone cannot fully address challenges associated with germplasm variation, changes in cultivation environments, regional quality differences, product authenticity, and alterations in active-component release and safety during processing. Therefore, this study further integrates key technical processes involved in *G. lucidum* spore powder production to establish a comprehensive technology system covering strain breeding, cultivation regulation, harvesting and processing, and quality evaluation. The proposed system aims to improve spore powder yield and batch stability, ensure product authenticity and safety, strengthen the control of characteristic active components, and provide a theoretical basis and technical reference for promoting the transformation of the *G. lucidum* industry from traditional experience-based management toward standardized, precise, and data-driven production models.