

Feature Review

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Environmental Control and Standardized Production in Facility-Based *Ganoderma lucidum* Cultivation

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Abstract This study explores the key technical pathways for environmental control and standardized production in facility-based *Ganoderma lucidum* cultivation. As market demand for *G. lucidum* products continues to expand, the limitations of traditional cultivation methods in precise environmental regulation, product quality consistency, and production standardization have become increasingly evident. This paper analyzes the specific requirements of *G. lucidum* growth for temperature, humidity, light, CO₂ concentration, substrate, and a clean cultivation environment. It summarizes facility-based production models, including greenhouse cultivation, intelligent mushroom houses, multi-layer bag cultivation, and liquid fermentation, with emphasis on temperature and humidity control, ventilation and light regulation, clean-environment management, and pest and disease prevention. Meanwhile, the standardized production process of *G. lucidum* is reviewed in terms of strain selection, substrate standardization, cultivation bag preparation, sterilization and inoculation, fruiting management, harvesting and processing, and quality evaluation. The study suggests that the application of IoT monitoring, automated regulation, data analysis, and intelligent management technologies can improve the precision, standardization, and traceability of *G. lucidum* production. In the future, regionalized cultivation technology systems, breeding and promotion of superior varieties, and branding and product traceability systems should be further strengthened to promote the high-quality, green, and intelligent development of the *G. lucidum* industry.

Keywords *Ganoderma lucidum*; Facility-based cultivation; Environmental control; Standardized production; Intelligent management

1 Introduction

Ganoderma lucidum is one of the traditional valuable medicinal fungi in China. It was classified as a “superior-grade” medicinal material in *Shennong’s Classic of Materia Medica* and has long been recognized for its medicinal value in tonifying qi, calming the mind, and strengthening healthy qi. Modern studies have shown that *G. lucidum* is rich in bioactive compounds such as polysaccharides and triterpenoids, which exhibit various pharmacological activities, including immunomodulatory, antioxidant, antitumor, and metabolic regulatory effects. Therefore, its application value in food, nutritional supplements, pharmaceuticals, functional products, and wellness markets has continued to increase (Thakur et al., 2024). In recent years, with the rapid development of the health industry and the increasing health awareness of consumers, market demand for *G. lucidum*-related products has continued to expand. The stable and large-scale supply of safe, high-quality *G. lucidum* raw materials and derivative products has become an important foundation for supporting industrial development (Wu et al., 2024). However, traditional *G. lucidum* cultivation systems still have certain limitations in yield stability, quality consistency, resource-use efficiency, and contamination control. Some production practices still rely on experience-based management, which may lead to imprecise environmental regulation, large variations in product quality, frequent occurrence of pests and diseases, and inconsistent production standards. These problems make it difficult to meet modern market demand for high-quality, safe, and stable *G. lucidum* products (Ghafoor et al., 2024). Therefore, promoting technological upgrading and the construction of standardized production systems has become a practical requirement for the high-quality development of the *G. lucidum* industry.

G. lucidum is a typical wood-decaying fungus, and its mycelial growth and fruiting body formation are highly sensitive to environmental conditions such as temperature, humidity, light, air circulation, CO₂ concentration, and