Medicinal Plant Research 2026, Vol.16, No.3, 205-220
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Research Insight Open Access

Construction of an Efficient Production and Quality Control Technology System for *Ganoderma lucidum* Spore Powder

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Medicinal Plant Research, 2026, Vol.16, No.3 doi: 10.5376/mpr.2026.16.0013
Received: 08 Apr., 2026
Accepted: 18 May, 2026
Published: 30 May, 2026

Preferred citation for this article:
Jiang X.J., 2026, Construction of an efficient production and quality control technology system for *Ganoderma lucidum* spore powder, Medicinal Plant Research, 16(3): 205-220 (doi: 10.5376/mpr.2026.16.0013)

Abstract This article analyzes the construction of an efficient production and quality control technology system for *Ganoderma lucidum* spore powder, focusing on key technical aspects including elite strain selection, culture medium optimization, precise regulation of cultivation environments, establishment of high-yield spore production models, spore collection and processing technologies, and quality evaluation methods. The available evidence indicates that breeding high-spore-yield and contamination-resistant strains is an important foundation for improving production efficiency. Optimization of medium composition and environmental factors such as temperature, humidity, light, and aeration can promote spore formation and the accumulation of bioactive components. Sporoderm-breaking and sporoderm-removal technologies can improve the release efficiency of active compounds, but they should be developed with consideration of both bioactive preservation and processing safety. For quality control, a multi-indicator comprehensive evaluation system should be established by integrating appearance characteristics, physicochemical parameters, multi-component detection, authenticity identification, and safety assessment. Meanwhile, standardized production processes, digital environmental monitoring, and industrial chain extension will further promote the transformation of the *G. lucidum* spore powder industry from experience-based management toward precision and intelligent production. This study provides a theoretical basis and technical reference for high-quality production, quality control, and industrial upgrading of *G. lucidum* spore powder.
Keywords *Ganoderma lucidum* spore powder; strain breeding; cultivation regulation; quality evaluation; standardized production

1 Introduction

Ganoderma lucidum is a medicinal and edible fungus with a long history of use in Asia, and its modern industrial development has accelerated as its bioactive components and health-related applications have become better characterized. Recent reviews describe *G. lucidum* as an important source of polysaccharides, triterpenoids, sterols, lipids, proteins, and other secondary metabolites with immunomodulatory, antioxidant, anti-inflammatory, antitumor, antidiabetic, hepatoprotective, and antimicrobial potential (Swallah et al., 2023; Ahmad et al., 2024). Against this background, *G. lucidum* products have expanded from traditional decoctions to powders, capsules, nutraceuticals, functional foods, and pharmaceutical preparations, and the international development of *G. lucidum*-based products is continuing to grow (Yeung et al., 2022). Among these products, spore powder is widely recognized as a high-value form because it concentrates the reproductive essence of the fungus and has become extensively consumed as a functional food and dietary supplement, especially in China (Ren et al., 2025). Studies further note that *G. lucidum* spore powder contains abundant active constituents, and some reports indicate that the contents of major ingredients such as polysaccharides can exceed those of the fruiting body, while wall-broken or wall-removed spores improve the release and absorption of these compounds because the natural sporoderm is difficult to digest and degrades poorly (Shen et al., 2020; Tang et al., 2023). Consistent with this utilization value, recent chemical studies have identified 142 compounds in spore powder, including lipids, triterpenes, alkaloids, organic acids, sterols, and fatty acids, providing a material basis for its continued development in health foods, medicines, and related high-value products (Zhang et al., 2024).