

Research Article

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Bulb Propagation Techniques and Large-scale Production Application of *Fritillaria thunbergii* Miq.

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Abstract *Fritillaria thunbergii* Miq. is an important medicinal plant resource in China, and the quality of its bulbs directly affects medicinal yield and the accumulation of active compounds. With the expansion of the cultivation industry, traditional bulb propagation methods have shown limitations, including low propagation efficiency, unstable seed source quality, and insufficient capacity for large-scale supply, which restrict the sustainable development of the *F. thunbergii* industry. This review focuses on bulb propagation techniques and large-scale production applications of *F. thunbergii*. The biological characteristics, bulb formation patterns, and major factors affecting bulb quality were systematically summarized, and key propagation technologies, including conventional bulb division, bulb scale propagation, and tissue culture, were reviewed. Furthermore, methods for establishing standardized seed source systems were discussed from the perspectives of bulb morphological traits, nutrient accumulation, physiological indicators, and quality evaluation. The application of regionalized propagation models, integration of bulb propagation with storage and production technologies, and the role of high-quality bulbs in promoting industrial development were also analyzed. In response to current challenges, including insufficient propagation efficiency, incomplete quality evaluation systems, and limited application of digital management, future development strategies involving rapid multiplication technology optimization, standardized quality control, and precision production management were proposed. This study provides theoretical references and technical support for high-quality seed bulb production, large-scale cultivation, and sustainable development of the *F. thunbergii* industry.

Keywords *Fritillaria thunbergii*; Bulb propagation; Bulb reproduction; Tissue culture; Large-scale production

1 Introduction

Fritillaria thunbergii Miq., the source plant of *Fritillariae Thunbergii* Bulbus (Zhebeimu), is a long-used traditional Chinese medicinal species whose dried bulbs are valued for antitussive, expectorant, anti-inflammatory, anti-ulcer, analgesic, and other pharmacological activities (Nile et al., 2021). It is one of the officially recognized medicinal *Fritillaria* sources in the Chinese Pharmacopoeia and is widely cultivated in southeastern and east-central China, especially in Zhejiang, Jiangsu, Anhui, Hunan, and major authentic-production areas such as Ningbo and Pan'an (He et al., 2021; Liu et al., 2025). Because its bulbs contain diverse bioactive constituents, particularly steroidal alkaloids such as peimine and peiminine, *F. thunbergii* has become one of the representative medicinal bulbs within the Beimu market and an important component of the “Zhejiang Eight Flavors” geo-authentic medicinal industry (Huang et al., 2024). At the same time, the broader *Fritillaria* market has substantial and persistent demand, and artificial cultivation has been recognized as a necessary strategy to protect wild resources and relieve the contradiction between supply and demand in medicinal *Fritillaria* industries. Although *F. thunbergii* itself has a long history of commercial bulb reproduction in China, with bulb propagation technology adopted centuries ago, the contemporary industry still faces unstable quality and yield, inefficient cultivation links, and market pressures that increasingly demand standardized, high-quality propagation materials for sustainable large-scale production (Qu et al., 2022).

The quality of propagation bulbs directly influences field establishment, vegetative growth, resistance performance, final yield, and the formation of medicinal quality in *F. thunbergii*. In medicinal production,