

Feature Review

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Construction of a Technical System for Rhizome Propagation and High-Quality Seedling Production of *Polygonatum sibiricum*

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Abstract As an important medicinal-and-edible homologous plant, *Polygonatum sibiricum* has long faced challenges such as declining wild resources, germplasm confusion, and insufficient supply of high-quality seedlings, which restrict the large-scale and standardized development of the industry. This paper focuses on rhizome propagation and high-quality seedling production of *P. sibiricum* and systematically constructs a technical system from the biological basis of propagation to large-scale production. First, the biological basis of rhizome regeneration and germination is clarified from the perspectives of rhizome structural characteristics, reserve accumulation, and environmental regulation mechanisms, highlighting the key roles of bud differentiation and carbohydrate reserves in vegetative propagation capacity. Second, multiple propagation pathways, including division propagation, segment propagation, and tissue culture, are systematically summarized, and their differences in propagation efficiency, resource consumption, and industrial applicability are compared. A production model combining rapid multiplication through tissue culture with field division for mother-stock maintenance is proposed. In seedling production, a standardized cultivation system is further constructed from the aspects of site selection, substrate formulation, water-fertilizer management, shading regulation, and green pest and disease control. Finally, a comprehensive quality grading standard integrating morphological indicators, root traits, physiological and biochemical indicators, and stress resistance evaluation is established, while storage and vigor maintenance techniques are incorporated to improve the seedling production chain. This system aims to enhance seedling uniformity and propagation efficiency of *P. sibiricum*, providing theoretical and technical support for rapid multiplication of elite germplasm, standardized production, and sustainable industrial development.

Keywords *Polygonatum sibiricum*; Rhizome propagation; Tissue culture; Seedling quality evaluation; Standardized production

1 Introduction

Polygonatum sibiricum is a widely used traditional medicinal and edible plant in East Asia, and its rhizome has been recorded in classical materia medica and used for food and medicine for centuries. Modern studies show that its rhizomes contain polysaccharides, saponins, flavonoids, alkaloids, phenolic acids, and other bioactive constituents that support broad pharmacological activities, including antioxidant, anti-inflammatory, hypoglycemic, immunomodulatory, antitumor, neuroprotective, and lipid-regulating effects (Pan et al., 2022; El-Hack et al., 2025). Among these constituents, *Polygonatum sibiricum* polysaccharides are regarded as major active substances and have attracted sustained attention for their roles in functional foods, nutraceuticals, and pharmaceutical development (Cui et al., 2018; Yang et al., 2024). In addition to medicinal application, *Polygonatum sibiricum* is recognized in China as a medicinal-and-edible homologous resource and has been developed into teas, beverages, oral liquids, powders, pills, and other health products, indicating a clear extension from traditional herb use to diversified industrial utilization (Li et al., 2025). This expanding scientific basis and product diversification have increased the medicinal, nutritional, and economic value of *Polygonatum sibiricum*, making it an important raw material for the health industry and a promising forest-understory crop (Su et al., 2018; Liao et al., 2023).

Driven by these values, market demand for *Polygonati Rhizoma* has risen substantially in recent years, and artificial cultivation has gained attention because demand has outpaced the supply capacity of natural populations