Medicinal Plant Research 2026, Vol.16, No.5, 371-386
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Meta Analysis Open Access

Optimization of Primary Processing and Commercial Grade Classification System for *Polygonatum*

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Medicinal Plant Research, 2026, Vol.16, No.5 doi: 10.5376/mpr.2026.16.0024
Received: 08 Aug 2026
Accepted: 20 Sep., 2026
Published: 17 Oct., 2026
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Preferred citation for this article:
Ma J.K., 2026, Optimization of primary processing and commercial grade classification system for *Polygonatum*, Medicinal Plant Research, 16(5): 371-386 (doi: 10.5376/mpr.2026.16.0024)

Abstract *Polygonatum* is an important medicinal and edible resource, and its commercial quality is influenced by multiple factors, including botanical origin, production environment, cultivation years, harvest time, and primary processing methods. To improve the stability of primary processing quality and the scientific basis of commercial specification grading, this paper systematically analyzes the raw material basis of *Polygonatum* quality formation, as well as the effects of key processing steps, including cleaning and sorting, steaming or boiling, drying, shaping, and storage, on rhizome morphology, color, texture, and internal chemical composition. Existing studies indicate that different botanical sources and raw material specifications show marked morphological and chemical variation, while repeated steaming and drying can continuously alter polysaccharides, fructans, saponins, and other constituents; excessive processing may result in the loss of certain bioactive components. Traditional commercial grading mainly relies on external characteristics such as size, integrity, color, and origin, but it remains limited by insufficient quantification, inconsistent standards among production areas, and incomplete correspondence between appearance grade and internal quality. Accordingly, this paper proposes a multi-indicator commercial grading system based on botanical origin and raw material specifications, integrating external traits, processing quality, moisture content, internal quality indicators such as polysaccharides and saponins, and rapid detection technologies. The proposed system follows a hierarchical framework of "basic qualification–external specification–processing quality–internal quality" and can be further standardized through graded processing, control of key processing parameters, batch documentation, and quality traceability. This framework may provide a reference for standardizing the primary processing of *Polygonatum*, stabilizing commercial quality, promoting classified utilization, and improving market circulation standards.
Keywords Polygonatum; Primary processing; Commercial specification; Quality grading; Quality control

1 Introduction

Polygonatum is an important medicinal-and-edible resource whose rhizomes have been used for more than two millennia in China and other parts of Asia, and the genus is broadly distributed across the temperate Northern Hemisphere (Shu et al., 2026). Current official medicinal materials are mainly derived from the dried rhizomes of *Polygonatum cyrtonema*, *P. sibiricum*, and *P. kingianum*, which are recognized in the Chinese Pharmacopoeia as major botanical sources of Polygonati Rhizoma (Liao et al., 2023). As a homologous food and medicine resource, *Polygonatum* is rich in polysaccharides, saponins, flavonoids, amino acids, fructans, and other nutritional or functional constituents, which support reported activities such as hypoglycemic, hypolipidemic, antioxidant, immunomodulatory, anti-fatigue, and anti-aging effects (Xiao et al., 2024). In addition to medicinal use, its rhizomes have historically served as a famine-relief food and are now developed into wines, teas, beverages, yogurt, powders, biscuits, snacks, and other functional products, reflecting a strong commodity production basis and expanding industrial value (Cheng et al., 2026). Recent agronomic and germplasm studies further show that *Polygonatum* resources exhibit substantial variation in yield, morphology, and chemical composition across species, provenances, cultivation environments, and growth years, which creates both opportunities for quality-oriented production and challenges for standardization.

From the perspective of commodity production, the resource endowment of *Polygonatum* is accompanied by rising market demand, but also by constraints related to wild resource depletion, mixed germplasm, unstable quality, and incomplete domestication. Wild *Polygonatum* resources are decreasing because of overharvesting and