environmental pressure, while artificial cultivation has become an important route for securing raw materials for the medicinal, food, and health-product industries. Annual demand in China has been estimated at 3.5×10^6~4.0×10^6 kg, and cultivated production can generate considerable economic returns, indicating that *Polygonatum* has already become a characteristic understory economic crop with significant social and industrial benefits (Cheng et al., 2026). At the same time, origin, climate, species, variety, and growth year all influence metabolite accumulation and nutritional quality, and elite materials differ markedly in polysaccharide content, fiber, mineral composition, and broader metabolomic profiles. This heterogeneity means that establishing a stable commodity production basis for *Polygonatum* cannot rely only on botanical identification or yield, but must also integrate resource evaluation, raw-material selection, and quality-linked grading criteria (Liao et al., 2023).

Primary processing is a decisive link connecting fresh rhizome resources with commercial products, because raw *Polygonatum* contains irritating substances such as calcium oxalate raphides and therefore usually requires postharvest treatment to reduce throat irritation, improve edibility, facilitate storage, and enhance tonic efficacy (Guo et al., 2026). Traditional methods are diverse, including single steaming, repeated steaming, nine steaming and nine basking, wine-processing, and processing with auxiliary materials, but modern production still lacks precise control of processing parameters, leading to uneven product quality (Bi et al., 2025). Existing studies show that different processing methods and processing intensities significantly alter appearance, color, sweetness, viscosity, polysaccharides, saponins, low-molecular-weight fructans, volatiles, and antioxidant-related traits (Mei et al., 2025). Several studies even suggest that the traditional nine-cycle process may involve over-processing, because key saccharides or fructans tend to stabilize or decline substantially after four to six cycles, whereas some simplified methods or wine-assisted processing can yield better comprehensive quality (Zhu et al., 2022). Despite this progress, commercial grading research remains comparatively weak: current practice often depends on empirical judgment of shape, size, and color, while multidimensional, quantitative systems linking external traits with intrinsic metabolites are only beginning to emerge. Recent work indicates that appearance traits, chromatic values, and multi-index chemical markers can be combined through chemometrics to classify samples and evaluate quality objectively, providing a methodological basis for commercial grade classification.

Against this background, the purpose of this review is to synthesize evidence on primary processing optimization and propose a scientifically grounded commercial grade classification framework for Polygonati Rhizoma that coordinates sensory characteristics, processing degree, and intrinsic quality indicators. Such a study is necessary because current research has emphasized either compositional transformation during processing or germplasm-level quality differences, but has not sufficiently connected processing-induced changes, quality control, and commodity specification in a unified framework. By integrating external morphology, color or slice characteristics, and representative bioactive constituents such as polysaccharides, saponins, and related markers, it becomes possible to move from experience-based judgment toward standardized, reproducible, and industry-applicable evaluation of *Polygonatum* raw and processed products. The establishment of an optimized primary processing route and commercial grading system would help preserve effective components while avoiding unnecessary over-processing, improve batch consistency, support raw-material procurement and market circulation, and provide a technical basis for the standardized, high-value, and sustainable development of the *Polygonatum* industry. In this sense, optimizing primary processing and commercial classification is not only a quality-control issue, but also a key step for transforming *Polygonatum*'s rich biological resources into stable, high-quality, and competitive commodities.

2 Raw Material Basis for the Formation of *Polygonatum* Commodity Quality

2.1 Effects of botanical origin and production area conditions on raw material quality

The three official botanical sources of Polygonati Rhizoma, *Polygonatum cyrtonema*, *P. sibiricum*, and *P. kingianum*, differ significantly in agronomic traits, yield, and chemical composition, establishing species identity as a primary determinant of raw material quality (Cheng et al., 2026). A common garden experiment across five species confirmed that saponin and polysaccharide contents, stem diameter, and inflorescence length vary substantially by species, with *P. cyrtonema* demonstrating high-yield potential up to 7.5 tons per hectare in Zhejiang (Liao et al., 2023). Within *P. cyrtonema* and *P. sibiricum*, five distinct rhizome types-"Jitou-type",