

conservation of elite *T. hemsleyanum* germplasm resources, rational utilization of forest-land resources, and ecological under-forest production. It also seeks to improve product quality consistency and market competitiveness, promote the transformation of local medicinal plant resource advantages into industrial advantages, and provide theoretical and practical support for the coordinated development of regional specialty agriculture, the under-forest economy, and the health industry.

2 Characteristics and Development Basis of Local *Tetrastigma hemsleyanum* Resources

2.1 Distribution of germplasm resources and characteristics of local types

Tetrastigma hemsleyanum is a perennial medicinal vine endemic to subtropical China and is distributed mainly in regions south of the Yangtze River, including Zhejiang, Fujian, Jiangxi, Hunan, Guangxi, Guizhou, Yunnan, Guangdong, Chongqing, and Taiwan, with Guangxi and Zhejiang recognized as areas with relatively abundant diversity (Chen et al., 2022; Han et al., 2026). Field and survey studies further show that this species typically occurs in valleys, shrubs, forests, gullies, slopes, moist grasslands, rock crevices, and valley streams, usually under scattered light and at elevations of about 300-1300 m, indicating a distinct dependence on shaded, humid, and relatively specific mountain habitats. In Guangxi, wild populations are concentrated mainly in the north and west, and the associated plant communities include tree, shrub, and herb layers with more than 50 accompanying species, which reflects the ecological complexity of the local germplasm habitat. Across its full range, the species spans broad longitudinal, latitudinal, and elevational gradients, which provides the environmental basis for the differentiation of local germplasm and adaptive types.

Local types of *T. hemsleyanum* show both shared species traits and geographically structured variation. Morphologically, the plant is a climbing liana with slender stems, trifoliate leaves, and spindle-, ovate-, or calabash-shaped tuberous roots, while root tubers from different regions generally retain similar external and microscopic diagnostic features, making simple morphology insufficient for origin discrimination (Dong et al., 2022). However, genetic studies consistently show clear differentiation among regional germplasms. ISSR analysis of 24 accessions detected definite genetic diversity and grouped samples into four clusters, with Zhejiang materials clustering independently and Guizhou germplasm forming a separate group. A larger ISSR-SRAP study of 27 accessions also found a clear clustering pattern corresponding to geographic distribution, higher similarity within populations than between populations, and higher similarity in cultivated than wild populations. Landscape genomics further resolved four major genetic groups corresponding broadly to Southwest, Central, South, and East China, confirming that local types are not only regional production concepts but genetically structured resource units shaped by long-term environmental differentiation.

2.2 Differences in resource quality and ecological conditions among different producing areas

The quality of *T. hemsleyanum* resources differs substantially among producing areas, and these differences are closely tied to both germplasm background and ecological conditions. Comparative genomic and pharmacognostic studies note that although root tubers from Zhejiang, Fujian, Jiangxi, Guangxi, and Sichuan are similar in external shape and microstructure, significant regional differences still exist in yield and medicinal quality, indicating that quality variation cannot be reliably judged by appearance alone. Evidence across several studies shows that samples from Zhejiang and Fujian had the highest total flavonoid contents and the strongest inhibitory activity against HepG2 cells, highlighting the importance of geographical origin in determining functional quality (Dong et al., 2022). Broader metabolomic work on 254 samples from eight areas identified 49 potential chemical markers and further linked origin to differences in metabolic profiles and antioxidant-related quality markers such as catechin and darendoside B (Chu et al., 2024). A multi-constituent comparison across southeastern and southwestern habitats likewise found significant differences in 60 bioactive compounds and concluded that southeastern samples were superior overall in quality evaluation (Chen et al., 2022).

Regional quality divergence is inseparable from ecological heterogeneity. *T. hemsleyanum* grows best under moist, shaded, acidic conditions, with suitable temperatures around 18~25 °C, pH 5.0~7.0 soils, and mountain habitats that buffer excessive light and drought stress. Seasonal and climatic factors directly influence metabolite accumulation: under precipitation of 2.0~6.6 mm, temperature of 17.5~24.1 °C, humidity of 67.3~80.2%, and