broader route is supported by compositional studies showing that leaves contain significantly higher flavonoid and phenolic-acid levels than roots and stems, with 24 compounds detected only in leaves, while leaves and fibrous roots have been proposed as potential new medicinal parts (Luo et al., 2022). Functional studies strengthen that case: leaf phenolics and their metabolites ameliorated DSS-induced colitis through barrier protection, oxidative-stress reduction, and gut-microbiota regulation, while aboveground polysaccharides showed macrophage immune-enhancing activity (Wu et al., 2021; Tian et al., 2025).

Deep processing should be paired with quality-oriented process optimization and origin-based branding. Extraction studies show that process conditions strongly affect active-compound yield, with optimized ethanol-ultrasound extraction producing a total yield of 788.12 mg/kg for five major flavonoids and strong DPPH scavenging activity (Shu et al., 2023). Processing method also affects efficacy: freeze-dried products preserved bioactive constituents better and showed the strongest hepatoprotective effect among three processed forms (Xu et al., 2026). Polysaccharide deep processing is also advancing, as optimized ultrasonic extraction has yielded structurally defined glucans with significant antipyretic activity, providing a clearer route from local resource to high-value product (Ding et al., 2025). Finally, regional branding should rely on scientifically verified origin-quality relationships, because root price already varies by origin and metabolomic studies across eight producing areas identified 49 potential chemical markers, including catechin and darendoside B as antioxidant-related quality markers (Chu et al., 2024). Building local public brands around authenticated provenance, standardized processing, and diversified products would align well with the species' established identity as Zhejiang's "New Zhebawei" and help convert local characteristic resources into an integrated under-forest specialty industry (Bai et al., 2022).

8 Conclusions and Perspectives

Tetrastigma hemsleyanum possesses traditional medicinal, edible, and modern pharmacological value, making it a local characteristic medicinal plant resource with considerable industrial potential. In addition to its traditionally used tuberous roots, the leaves, stems, and other aboveground parts are also rich in flavonoids, polysaccharides, phenolic acids, and other bioactive constituents, showing potential for further development into functional foods and plant-derived products. Its shade-tolerant and moisture-preferring ecological characteristics are highly compatible with under-forest environments characterized by relatively low light intensity, stable temperature and humidity, and active soil microecology. Therefore, under suitable conditions, under-forest cultivation can support quality formation. Future local industrial development should fully integrate local germplasm resources, suitable forest stands, and ecological conditions to establish a characteristic industry system based on high-quality resources and ecological production.

At present, the *T. hemsleyanum* industry still faces several major challenges, including a fragile resource base, insufficient standardization, and a relatively short industrial chain. Wild resources have long been subjected to overharvesting, while the long growth cycle, low seed yield, and limited efficiency of conventional propagation continue to restrict the stable supply of elite germplasm and high-quality seedlings for large-scale production. Meanwhile, substantial differences in yield and quality occur among producing areas, habitats, and cultivation models, and standardized under-forest cultivation technologies with strong regional adaptability are still lacking, particularly for light, moisture, soil, and stand management. In the processing sector, problems such as limited product diversity, incomplete quality-control systems, insufficient industrial application of deep-processing technologies, and inadequate traceability of geographical origin and cultivation mode continue to hinder the transformation of local resource advantages into brand and market competitiveness.

Future development should promote the coordinated upgrading of the under-forest *T. hemsleyanum* industry through germplasm conservation, ecological cultivation, and industrial value addition. Upstream efforts should strengthen surveys of local germplasm resources, selection of elite germplasm, and rapid propagation technologies to establish a stable system for improved-variety breeding and seedling supply. At the production level, shading, water management, soil conditions, microbial regulation, and cultivation practices should be optimized according to germplasm and forest-site conditions to achieve standardized production and precise ecological regulation. Downstream development should emphasize comprehensive utilization of both tuberous roots and aboveground