

4.2 Expansion of midstream deep-processed products

Deep processing is an important pathway for increasing the added value of the Hangbaiju industry and enhancing market competitiveness. For a long time, the Hangbaiju industry has mainly relied on dried flower sales and simple packaged products, with a relatively low level of processing and obvious product homogenization, making it difficult to fully release the functional value of this medicinal and edible resource. Studies on Hangbaiju flavonoid extraction show that green technologies such as ultrasonic-assisted extraction and enzymatic extraction can significantly increase the yield of active substances and improve their stability, providing technical support for the application of Hangbaiju in tea beverages, capsules, nutritional supplements, and other products. Research on tea product diversification also indicates that transforming low-value primary tea into high-value-added products such as liquid beverages, instant powders, concentrates, fermented drinks, and nutraceuticals is an important way to increase industrial returns and cope with rising production costs (Liang et al., 2021; Zohora and Arefin, 2022).

In terms of product development, comprehensive utilization research can be carried out around flavonoids, polyphenols, and volatile components in Hangbaiju to develop diversified products such as ready-to-drink tea beverages, instant granules, functional concentrates, plant-based beverages, and compound herbal drinks. At the same time, in line with the development trend of medicinal and edible resources, Hangbaiju can be applied to functional foods, solid beverages, substitute teas, healthy snacks, and cross-category bakery products, forming a multi-level product system centered on functional positioning such as “soothing,” “eye care,” “antioxidant,” and “light wellness” (Liang et al., 2021; Huda et al., 2024; Lu and Liu, 2025). Developing low-sugar, sugar-free, highly functional, and portable products according to the needs of different consumer groups can also improve market adaptability and product coverage.

In addition, processing enterprises should strengthen cooperation with universities and research institutes to promote the development of new processes, new equipment, and new products. Low-carbon ecological tea research emphasizes that midstream technological innovation should focus on energy-saving equipment, by-product recycling, and derivative product development (Zhang et al., 2024). For Hangbaiju, regional processing centers or industrial innovation platforms integrating flower drying, active component extraction, beverage manufacturing, by-product utilization, and quality testing can be established. Clean energy, intelligent equipment, and resource utilization of by-products can be used to improve industrial chain efficiency. For example, Hangbaiju processing residues can be used in fertilizers, feed, or plant-based raw material development, thereby improving resource utilization and reducing environmental pressure. Research on advanced tea beverage processing also shows that cold extraction, ultrasonic extraction, enzymatic treatment, and fermentation are important technical tools for enhancing the flavor and functionality of tea beverages (Liang et al., 2021; Liu et al., 2024). Embedding these technologies into the Hangbaiju deep-processing system can help promote the transformation of Hangbaiju from a primary agricultural product into branded, functional, and high-value products.

4.3 Extension of downstream sales channels and consumption scenarios

Sales channel innovation is an important link in realizing industrial chain value. In the downstream sector, the focus of Hangbaiju industrial chain extension lies in expanding sales channels for tea beverage products and enriching consumption scenarios. With the development of the Internet economy and digital consumption models, Hangbaiju product sales have gradually shifted from traditional wholesale and physical retail toward integrated online and offline models. Studies on the herbal tea and new-style tea beverage markets show that consumer demand for convenient, standardized, health-oriented, and naturally functional beverages is growing rapidly (Figure 2) (Huda et al., 2024; Carbone et al., 2025). Research on the globalization of Chinese herbal tea also points out that transforming loose traditional tea into fast, convenient, and standardized beverages is an important pathway for entering international markets and building sustainable value networks. Therefore, Hangbaiju tea beverages should further expand from traditional agricultural product sales channels into diversified channels such as specialty tea shops, cafés, supermarkets, convenience stores, e-commerce platforms, cross-border e-commerce, and functional beverage shelves.