evaluation, and molecular marker-assisted evaluation (Zhang et al., 2022; Zhang et al., 2024). Sensory evaluation mainly relies on comprehensive assessment of fruit size, color, aroma, sweetness and acidity, taste, and texture, which can directly reflect consumer experience. However, because sensory evaluation is easily influenced by subjective factors, it is usually combined with objective physicochemical indicators for comprehensive analysis. Physicochemical measurements are currently the most widely used methods and mainly include soluble solids, titratable acidity, sugar-acid ratio, vitamin C, total phenolics, total flavonoids, anthocyanins, fruit firmness, and color parameters. Among these, soluble solids and sugar-acid ratio are commonly used to evaluate fresh-eating quality, whereas anthocyanins, polyphenols, and antioxidant capacity are mainly used to evaluate functional quality.

In recent years, technologies such as high-performance liquid chromatography (HPLC), gas chromatography-mass spectrometry (GC-MS), electronic nose, electronic tongue, near-infrared detection, and image recognition have gradually been applied to Chinese bayberry quality evaluation, improving the accuracy and efficiency of quality detection (Gao et al., 2024). In statistical analysis, multivariate methods such as principal component analysis, cluster analysis, and correlation analysis have been widely used for dimensionality reduction and cultivar classification of quality data. By integrating indices such as sugar-acid ratio, anthocyanin content, total phenolic level, color parameters, and aroma compounds, different Chinese bayberry cultivars can be classified into sweet type, balanced sweet-sour type, dark high-anthocyanin type, and highly aromatic type (Zhang et al., 2022). In addition, in postharvest storage and processing studies, indicators such as decay rate, fruit firmness, titratable acidity, phenolic compounds, antioxidant enzyme activity, and volatile markers have gradually been incorporated into quality evaluation systems to assess shelf-life stability and flavor changes (Saeed et al., 2024).

At the molecular level, studies based on telomere-to-telomere (T2T) reference genomes and genome-wide association analysis have linked multiple standardized quality traits with specific SNP loci and candidate genes, providing an important foundation for molecular marker-assisted selection of superior external and internal quality traits in Chinese bayberry (Zhang et al., 2024). Meanwhile, analyses of the MYB transcription factor family and its regulatory networks have provided candidate gene resources for improving fruit color, flavonoid biosynthesis, and functional quality (Cao et al., 2021; Xue et al., 2024). Although a unified industrial quality evaluation standard has not yet been established, integrating sensory evaluation, physicochemical detection, functional activity, postharvest stability, and molecular markers has become an important trend in constructing comprehensive quality evaluation systems and promoting targeted quality improvement in Chinese bayberry.

3 Major Factors Affecting Fruit Quality of Chinese Bayberry

3.1 Variety factors

Cultivar is the fundamental factor determining the formation of fruit quality in Chinese bayberry. Significant differences exist among cultivars in fruit size, coloration, sugar and acid contents, aroma characteristics, nutritional composition, and accumulation of functional compounds. A systematic evaluation of 173 Chinese bayberry germplasm accessions demonstrated extensive phenotypic variation in 29 quality traits, including fruit color, size, sugars, organic acids, and amino acids. Most traits exhibited continuous distributions, indicating that Chinese bayberry quality traits possess a complex quantitative genetic basis (Zhang et al., 2024). Common commercial cultivars currently include ‘Dongkui’, ‘Biqizhong’, ‘Dingao’, and ‘Wandao’. Among them, ‘Dongkui’ is favored by the market because of its large fruit size, bright color, and excellent commercial quality, whereas ‘Biqizhong’ is characterized by rich flavor, balanced sugar-acid ratio, and high anthocyanin content in dark-colored fruits (Zhang et al., 2024).

Differences in genetic background among cultivars directly affect fruit color, ripening time, anthocyanin accumulation capacity, and antioxidant activity. Chinese bayberry germplasm resources include white, pink, red, and black-purple types, and these color types differ significantly in anthocyanin content, antioxidant capacity, and processing suitability (Xue et al., 2024). Dark-colored cultivars generally possess higher cyanidin-3-O-glucoside content and stronger antioxidant activity, making them more suitable for fresh consumption, high-anthocyanin products, and functional food development. In addition, different cultivars show distinct postharvest ethylene