4.3 Facility cultivation and green cultivation techniques

Facility cultivation and protected cultivation provide effective approaches for regulating temperature, light, and rainfall during critical periods of Chinese bayberry fruit development. Rain-shelter cultivation, greenhouse cultivation, insect- and rain-proof netting, and mulching cultivation can improve orchard microclimate and reduce the negative effects of continuous rainfall during the ripening period. Particularly during the fruit ripening stage, rainy weather often causes fruit cracking, decay, and disease occurrence, whereas rain-shelter facilities can reduce water accumulation on fruit surfaces and disease pressure, thereby improving fruit integrity, marketability, and postharvest storability.

Greenhouse cultivation can avoid the adverse effects of rainfall during harvest and improve single-fruit weight, fruit size, soluble solids content, and sugar-acid ratio, showing superior fruit quality compared with open-field cultivation. The physiological basis for these improvements may be associated with enhanced sucrose phosphate synthase activity and reduced acid invertase activity under greenhouse conditions, thereby promoting sucrose accumulation and improving sugar-acid quality (Wu et al., 2021). In controlled facility environments, LED supplemental lighting technology can further precisely regulate light intensity and spectral composition. For example, optimized LED supplemental lighting significantly increased fruit weight, soluble solids, and vitamin C content while reducing organic acid content in ‘Heitan’ Chinese bayberry. ‘Dongkui’ showed relatively weaker responses but still exhibited certain quality improvements, indicating cultivar-specific differences in light environment regulation requirements (Tang et al., 2025).

Green ecological cultivation technologies are important directions for the high-quality development of the Chinese bayberry industry. Their core objective is to maintain and improve fruit quality while reducing chemical inputs and improving orchard ecological environments. Intercropping ryegrass in Chinese bayberry orchards can improve soil physicochemical properties, rhizosphere microbial communities, and metabolic environments, thereby increasing fruit sugar, vitamin C, and flavonoid contents while reducing acidity (Li et al., 2023). Insect- and rain-proof nets, as green facility technologies, can simultaneously achieve pest control, rainfall exclusion, and microclimate regulation, thereby improving fruit size, edible rate, and economic benefits while reducing pesticide dependence (Yu et al., 2021). In addition, grafting ‘Biqizhong’ onto North American bayberry (*Morella cerifera*) rootstocks enables plants to maintain healthy growth under saline-alkaline soil conditions and increases fruit sucrose and citric acid contents, providing new possibilities for high-quality Chinese bayberry production in saline-alkaline areas (Saeed et al., 2023).

5 Research Progress in Detection and Evaluation Technologies for Chinese Bayberry Quality

5.1 Traditional detection methods

Traditional quality detection methods are an important foundation for evaluating Chinese bayberry fruit quality and are still widely used in scientific research, cultivar comparison, postharvest quality analysis, and commercial grading. Sensory evaluation is one of the most common traditional methods and mainly assesses overall fruit quality based on fruit color, size, shape, aroma, sweetness and acidity, flesh texture, juiciness, and overall acceptability. This method is highly intuitive and can directly reflect consumer perception of fresh fruit quality, thus playing an important role in fruit grading, market evaluation, and flavor description. Descriptive sensory analysis combined with physicochemical indices has been used to classify sweetness, acidity, and aroma characteristics among different Chinese bayberry cultivars, thereby providing a basis for selecting superior fresh-eating cultivars.

Physicochemical measurement is the core component of the traditional quality evaluation system and mainly includes soluble solids, titratable acidity, sugar-acid ratio, vitamin C, total phenolics, anthocyanins, fruit firmness, sugars, organic acids, and color difference parameters (Xuan et al., 2022). Among these, soluble solids are commonly used to reflect sugar content, whereas titratable acidity is used to evaluate acidity; together, they determine flavor balance in Chinese bayberry fruit. Vitamin C, polyphenols, and anthocyanins are often analyzed to evaluate nutritional and functional quality. Conventional analytical methods, such as refractometry for Brix determination, acid-base titration for titratable acidity, spectrophotometry for total phenolics and anthocyanins,