been applied for non-destructive detection of sugar and acidity in Chinese bayberry fruit, and their portability makes them more suitable for small-scale growers and field grading applications (Wang et al., 2023).

5.3 Intelligent evaluation technologies

In recent years, the rapid development of artificial intelligence, big data, machine vision, and the Internet of Things (IoT) has promoted the transformation of Chinese bayberry quality evaluation from traditional single-point detection to intelligent, real-time, and systematic approaches. Intelligent recognition technologies based on machine vision can automatically collect fruit images and use machine learning or deep learning algorithms to identify fruit size, color, defects, and maturity, thereby enabling rapid grading. Compared with traditional manual sorting, intelligent recognition technologies have advantages including fast detection speed, unified standards, traceability, and suitability for online deployment. In orchard production, machine vision can also be used to monitor fruit ripening processes and canopy growth status, thereby supporting timely harvesting and precision management (Knott et al., 2022).

In sensor data modeling, machine learning has become an important tool for constructing Chinese bayberry quality detection models. Electronic nose data combined with stochastic resonance signal processing and multivariate regression models can be used to predict firmness, pH, color, soluble solids, and reducing sugars with high prediction accuracy. In postharvest flavor evaluation, artificial neural network models can verify the classification performance of electronic noses in distinguishing normal-flavor and off-flavor fruits under different storage temperatures (Gao et al., 2024). In spectral detection, algorithms such as partial least squares analysis, principal component analysis, and artificial neural networks are often combined with Vis/NIR or hyperspectral data for acidity prediction, cultivar identification, and cross-batch model transfer (Yuan et al., 2025). These technologies improve detection efficiency and data processing capability, providing technical support for rapid and non-destructive quality evaluation of Chinese bayberry fruit.

Image-based deep learning technologies have also begun to be applied to maturity and quality detection in Chinese bayberry. Zheng et al. (2025) proposed a cascaded framework combining the lightweight instance segmentation model SOLOv2-Light and multi-feature regression for field maturity detection of Chinese bayberry fruit (Figure 3). After segmenting individual fruits, the system integrated deep semantic features, LAB color information, and multi-scale texture features, while using a/b values obtained by colorimeters as maturity labels, achieving high segmentation performance and low maturity prediction error. When maturity was divided into three levels, classification accuracy reached 95.5%. From the perspective of industrial applications, future intelligent quality evaluation of Chinese bayberry is expected to develop toward multi-source data fusion and online detection. In orchards, machine vision and IoT technologies can be combined to monitor fruit maturity, temperature, humidity, and soil moisture; in sorting facilities, hyperspectral imaging and Vis/NIR technologies can be used for automatic grading; and in processing plants, electronic noses, electronic tongues, and HS-GC-IMS can be used to monitor flavor stability (Dhiman et al., 2022; Apostolopoulos et al., 2023). With the development of lightweight models, portable sensors, and cloud platforms, Chinese bayberry quality detection is expected to achieve real-time application from laboratories to orchards, storage systems, and processing lines (Hassan et al., 2025; Júnior et al., 2025).

6 Current Problems in Existing Research

6.1 Insufficient research on the mechanisms of quality formation

In recent years, increasing attention has been paid to the mechanisms underlying Chinese bayberry fruit quality formation, and technologies such as genomics, transcriptomics, and metabolomics have gradually been applied to the analysis of quality traits. However, overall, the mechanisms governing fruit quality formation still lack systematic, in-depth, and experimentally validated theoretical explanations. At present, a high-quality telomere-to-telomere (T2T) reference genome and genome-wide association studies (GWAS) have linked 29 quality traits with 1 937 SNP loci and 1 039 candidate genes, and identified an important MYB/MLP regulatory locus associated with fruit color on chromosome 6 (Zhang et al., 2024). Nevertheless, for complex quality traits