variation (Li et al., 2026). Because quality is strongly affected by producing area, cultivation environment, and harvest conditions, the appearance evaluation system should record color uniformity, fineness, agglomeration, odor, and wall-breaking-related morphology together with origin and batch information (Ran et al., 2025).

Basic physicochemical testing should then focus on moisture, ash, and related compositional indicators that can reveal processing quality and raw-material purity. Moisture is especially suitable for rapid routine control, and near-infrared models have predicted moisture content in *G. lucidum* with good accuracy, supporting its use for fast non-destructive screening in production settings (Ni et al., 2023). Ash content also has discriminating value: one study found lower ash in Xiuyan samples than in first-grade Shandong spore powder, while third-grade Shandong samples had higher ash, indicating that mineral residue can reflect grade or impurity burden. Since pulverization changes sample homogeneity and may alter optical behavior, standardized sampling, particle-size control, and wall-breaking-rate evaluation are necessary to make physicochemical indicators comparable across lots (Ran et al., 2025). For rapid authenticity and sensory-style discrimination, emerging tools such as electronic nose, NIR, and hyperspectral imaging can complement conventional tests, especially for batch screening before confirmatory analysis (Figure 2) (Shi et al., 2022; Ran et al., 2025).

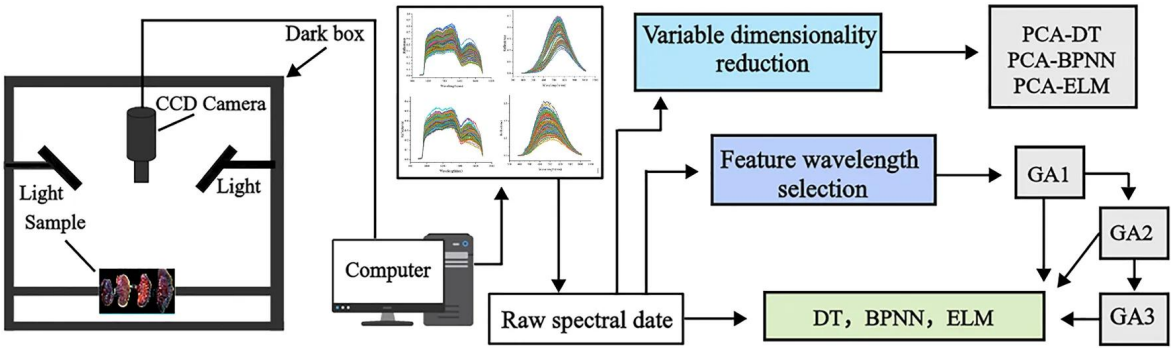

Figure 2 Schematic diagram of *Ganoderma lucidum* sample program analysis (Adopted from Ran et al., 2025)

4.2 Detection of active components and quality evaluation methods

Active-component control should center on polysaccharides, triterpenoids, sterols, lipids, proteins, and selected nucleoside-related markers, because these are the principal material basis of spore powder quality and function (Ran et al., 2025). Triterpenoids and polysaccharides are the most widely accepted core quality markers, and they are already used officially for *Ganoderma* quality assessment (Wu et al., 2017). Yet the evidence also shows marked quantitative variability across commercial products and regions: tested *Ganoderma* samples ranged from 0.22% to 3.31% polysaccharides and 0.21% to 10.56% total triterpenes, while LC-MS/MS-targeted triterpenes ranged from 0.01% to 0.98%, indicating that a single bulk index is not sufficient for refined quality grading (Liu et al., 2025). Regional spore-powder comparisons likewise found large differences in total sugars, polysaccharides, lipids, proteins, phenolics, total triterpenoids, ergosterol, and nucleosides, with substantial corresponding differences in antioxidant and enzyme-inhibitory activities (Li et al., 2026).

Accordingly, the quality evaluation method should combine targeted quantification with fingerprinting and authenticity tools. HPLC-DAD fingerprinting has been established for *Ganoderma* products using 13 candidate compounds, with 11 ganoderma acids identified as useful chemical markers and the method validated as accurate and feasible for quality control and identity determination (Yeung et al., 2022). For spores specifically, UPLC-Q-TOF-MS/MS identified nine confirmed triterpenoids and supported an HPLC method for simultaneous determination of five triterpenoids, with good linearity, acceptable recovery, and large habitat-related differences in content (Qiao et al., 2024). Polysaccharide evaluation can be strengthened by saccharide mapping and HPSEC-MALLS-RID, which showed potential for routine quality evaluation of polysaccharides in supplements (Wu et al., 2017). Molecular identification should also be included, because ITS2 barcoding precisely detected 16 adulterants among 84 commercial Ganoderma samples, and authenticity testing by NIR with chemometrics can rapidly identify dyed-starch adulteration and quantify its level with calibration and validation correlations above