SIFF 2026
Singapore International Food Forum 2026

AI-Assisted Spectroscopic Technologies for Rapid Food Control and Safety Surveillance

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Abstract

Conventional food control systems often rely on time-consuming, destructive, and solvent-intensive analytical methods, limiting their applicability for rapid and large-scale food surveillance. Recent advances in spectroscopy combined with chemometric and machine learning approaches offer promising alternatives for intelligent, rapid, and sustainable food monitoring systems [1].

This study highlights the application of AI-assisted spectroscopic technologies for rapid food control and safety surveillance through several case studies involving food authentication, contaminant detection, and sustainable food ingredient assessment. Various spectroscopic platforms, including attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR), visible-near infrared spectroscopy (Vis-NIR), and ultraviolet-visible spectroscopy (UV-Vis), were integrated with chemometric and machine learning approaches for qualitative and quantitative analysis.

The developed analytical models successfully enabled rapid detection of aflatoxins in peanuts using ATR-FTIR combined with multivariate analysis [2], authentication and quantification of cocoa powder adulteration using Vis-NIR spectroscopy and chemometrics [3], sugar profiling in high-fructose syrup using ATR-FTIR spectroscopy [4], non-destructive classification of peaberry coffee using near infrared spectroscopy and machine learning algorithms [5], and rapid determination of carrageenan composition in seaweed products using ATR-FTIR spectroscopy and chemometrics [6].

These methods demonstrated rapid analysis, minimal sample preparation, reduced solvent consumption, and good predictive performance for complex food matrices. The integration of spectroscopy, chemometrics, and AI-assisted analysis provides a promising strategy for future intelligent food surveillance systems that support sustainable, scalable, and real-time food control applications for regulatory agencies, industry, and food safety laboratories.

References

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