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I-CReST 2025:104-069 – Advancement in *Halalan Toyyiban* Laboratory Instrumentations for Sustainable Food Product Analysis

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ABSTRACT

The *halalan toyyiban* (HT) concept is crucial in ensuring food products adhere to both *halal* (permissible) and *toyyiban* (wholesome) Islamic dietary principal, addressing ethical, safety, and quality considerations in the global food industry. However, challenges such as complex food matrices and the presence of forbidden adulterants necessitate advanced analytical techniques for robust detection. This comprehensive review explores the advanced laboratory instrumentation for HT assurance, focusing on spectroscopic techniques such as Fourier Transform Infrared Spectroscopy (FTIR) for rapid, non-destructive analysis, chromatographic methods such as High-Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC) for precise quantification, and molecular approaches including Polymerase Chain Reaction (PCR) for high-sensitivity contaminant detection. Additionally, the microbiological assessments aspects ensure food safety and hygiene compliance. Beyond the analytical advancements, sustainability is increasingly integral for HT compliance, necessitating environmentally friendly detection methods, efficient resource utilization and reduced chemical waste in food product testing laboratories. Furthermore, this review also highlights the role of Multivariate Data Analysis (MVDA) in managing complex datasets, enhancing pattern recognition, and improving predictive modeling for more accurate decision-making for the HT aspects based on aforementioned laboratory instrumentations. While these methodologies offer significant advancements, challenges such as high costs, lack of standardization, and technical expertise remain key limitations. This study emphasizes the need for cost-effective, automated and standardized detection laboratory system that allign with sustainability goals, ensuring more efficient, accessible and environmentally responsible HT compliance framework for a reliable and ethical food product laboratroy results

Keywords: *Halalan toyyiban* authentication; Food safety and quality; Laboratory instrumentation; Analytical detection; Multivariate data analysis