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Emerging and Advanced Technologies for Halal Food Authentication

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INTRODUCTION & AIM

Ensuring the authenticity of halal food is essential for maintaining consumer trust, public health, and market integrity. For Muslims consuming halal food is a mandatory aspect of their faith and requires a rigorous verification. There are several food products in the market in which actual ingredients and their source are not mentioned on the label and cannot be observed by the naked eye. Various scientific databases were utilized to identify relevant articles, research papers and reports about halal food authentication. Methods like DNA-based Polymerase Chain Reaction, Fourier Transform Infrared Spectroscopy, Raman Spectroscopy, Gas Chromatography, High-Performance Liquid Chromatography and Enzyme-Linked Immunosorbent Assay were examined. Additionally, emerging technologies like blockchain for traceability and artificial intelligence for data analysis are explored.

METHOD

A comprehensive review of various technologies used for halal food authentication, including:

PCR: Detects species-specific DNA, useful for identifying non-halal components like pork.

FTIR: Analyzes molecular bonds, effective in detecting adulteration in food products.

Raman Spectroscopy: Provides detailed compositional analysis of ingredients.

GC and HPLC: Used to identify chemical compounds and fatty acids for halal verification.

ELISA: Uses antibodies to identify specific meat species in food products.

Emerging technologies like blockchain enhance transparency and traceability, while AI improves the accuracy of ingredient detection.

RESULTS & DISCUSSION

The reviewed methods offer improved accuracy and reliability in detecting non-halal substances in various food products, especially gelatin, meat, and dairy products. DNA-based methods like PCR are highly sensitive but expensive, while spectroscopy techniques like FTIR and Raman provide rapid and accurate results with minimal sample preparation. AI and blockchain further enhance traceability and prevent fraud.

Technique	Key Use	Advantages	Limitations
Polymerase Chain Reaction (PCR)	DNA-based detection of species (e.g., pork)	High sensitivity and specificity in detecting species	High cost and long analysis times
Fourier Transform Infrared Spectroscopy (FTIR)	Identifying functional groups in food substances	Minimal sample preparation, fast and sensitive	Limited to molecular-level contamination
Raman Spectroscopy	Fingerprinting and profiling compounds	Effective for detailed compositional analysis	Requires specialized equipment and expertise
Gas Chromatography (GC)	Identifying low molecular weight compounds	High accuracy and flow rates for volatile substances	Requires analyte derivatization for some substances
High-Performance Liquid Chromatography (HPLC)	Separating components in complex mixtures	Excellent for non-volatile and thermally unstable components	Expensive and time-consuming
Enzyme-Linked Immunosorbent Assay (ELISA)	Detecting specific proteins in food products	Cost-effective, convenient for rapid testing	Less sensitive than DNA-based methods like PCR

CONCLUSION

The integration of advanced technologies like PCR, FTIR, Raman Spectroscopy, and emerging technologies like AI and blockchain ensures the authenticity of halal food products. These methods address the limitations of traditional approaches, enhancing the integrity of halal certification and building consumer confidence in halal food markets.

REFERENCES

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