

[Results for THE FTIR-ATR S...](#) >

The FTIR-ATR Spectroscopy as a Biosensing Strategy for Thermal Effects in ...

[Free Full Text From Publisher](#)[Export ▾](#)[Add To Marked List](#)

< 1 of 1 >

The FTIR-ATR Spectroscopy as a Biosensing Strategy for Thermal Effects in Permissibility Verification of Lard-Adulterated Palm Oil

By

[Are you this author?](#)

[Nazri, MZ](#) (Nazri, Muhammad Zulhelmi) ^[1], ^[2]; [Zaidel, DNA](#) (Abang Zaidel, Dayang Norulfairuz) ^[1], ^[2]; [Sani, MSA](#) (Abdullah Sani, Muhamad Shirwan) ^[3]; [Karim, HAA](#) (Karim, Hajar Aminah A.) ^[2]; [Abd Rashid, SNA](#) (Abd Rashid, Siti Nor Azlina) ^[2], ^[4]; [Windarsih, A](#) (Windarsih, Anjar) ^[5]

[View Web of Science ResearcherID and ORCID](#) (provided by Clarivate)

Source

[JOURNAL OF CHEMOMETRICS](#)[← View Journal Impact](#)

Volume: 40 Issue: 6
DOI: 10.1002/cem.70137

Article Number

e70137

Published	MAY 31 2026		
Indexed	2026-06-05		
Document Type	Article		
Abstract	Ensuring authenticity of edible oils is vital for consumer trust, regulatory compliance and permissibility assurance, particularly for Muslim consumers. This study introduces a spectral biosensing strategy using Fourier transform infrared spectroscopy coupled with attenuated total reflectance (FTIR-ATR) and chemometric modelling to detect lard adulteration in palm oil (PO) under thermal stress. PO samples spiked with 1%-50% v/v lard were heated from 25 degrees C to 200 degrees C for 30 min, simulating industrial and culinary conditions. FTIR-ATR spectra showed distinct shifts in carbonyl and fingerprint regions due to lard incorporation and heat-induced lipid degradation. Discriminant analysis (DA) achieved 100% classification accuracy across the full spectrum (4000-650 cm⁻¹), demonstrating strong discriminatory power. Partial least squares-discriminant analysis (PLS-DA) identified the fingerprint region (1000-650 cm⁻¹) as most diagnostic, yielding robust performance with R²_Y = 0.895, R²_X = 1.000, Q² = 0.893 and 100% correct classification in both training and validation datasets. Principal component analysis (PCA) revealed clear clustering of pure and adulterated samples, even under severe thermal conditions. Moreover, using the optimised FTIR-ATR/PLS model, the lard adulteration in thermally treated PO could be reliably detected at levels as low as 1% v/v with LOD and LOQ ranges of 0.01%-1.14% and 0.02%-3.34% v/v, respectively. These findings position FTIR-ATR with multivariate chemometrics as a rapid, nondestructive and thermally resilient platform for lard detection in PO. The approach extends to broader food quality and safety monitoring in real-world processing scenarios.		
Keywords	Author Keywords: chemometric analysis; FTIR-ATR spectroscopy; lard adulteration; permissibility authentication; spectral biosensing Keywords Plus: TRANSFORM INFRARED-SPECTROSCOPY; EDIBLE OILS; FATTY-ACID; PRODUCTS		
Author Information	Corresponding Address:	Abang Zaidel, Dayang Norulfairuz	(corresponding author)

▼ Univ Teknol Malaysia UTM, Malaysia Japan Int Inst Technol
 MJIT, Kuala Lumpur, Malaysia
 Corresponding Abang Zaidel, Dayang (corresponding
 Address: Norulfairuz author)

▼ Univ Teknol Malaysia UTM, Innovat Ctr Agritechnol Adv
 Bioproc ICA, Pagoh, Johor, Malaysia
 E-mail Addresses :
dnorulfairuz@utm.my

Addresses :

▼ ¹ Univ Teknol Malaysia UTM, Malaysia Japan Int Inst Technol
 MJIT, Kuala Lumpur, Malaysia

▼ ² Univ Teknol Malaysia UTM, Innovat Ctr Agritechnol Adv
 Bioproc ICA, Pagoh, Johor, Malaysia

▼ ³ Int Islamic Univ Malaysia IIUM, Int Inst Halal Res & Training
 INHART, Level 3, KICT Bldg, Kuala Lumpur, Malaysia

▼ ⁴ Univ Teknol Malaysia UTM, Innovat & Commercializat Ctr
 ICC, Off Deputy Vice Chancellor Res & Innovat, Kuala Lumpur,
 Malaysia

▼ ⁵ Natl Res & Innovat Agcy BRIN, Res Ctr Food Technol & Proc
 PRTTP, Yogyakarta, Indonesia

E-mail Addresses :
mzulhelmin@utm.my; dnorulfairuz@utm.my;
shirwansany@iium.edu.my; hajar_a@utm.my;
sitinorazlina@utm.my

**Data availability
 statement**

The data that support the findings of this study are available
 from the corresponding author upon reasonable request.

**Conflict of
 interest
 statement**

The authors declare no conflicts of interest.