Rapid Detection of MOAH Contamination in Food Matrices Using A-TEEM and Machine Learning Models

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***Keywords*:** Machine learning, Food contamination, Analytical chemistry

***Abstract*:**

Mineral Oil Aromatic Hydrocarbons (MOAH) are hazardous contaminants that can enter food through packaging, environmental pollution, or industrial lubricants. The coupled HPLC-GC-FID method is the gold standard for MOAH analysis, but it is time-consuming and resource-intensive, limiting its suitability for routine screening. This study evaluates fluorescence spectroscopy with absorbance and transmittance as a rapid alternative for detecting MOAH contamination from high-risk sources along the supply chain.

Absorbance-Transmittance-Excitation Emission Matrix (A-TEEM) spectroscopy combined with machine learning algorithms was applied to sunflower oil, whole milk powder, and cocoa butter. Spectral datasets comprised 936 points for sunflower oil, 1,560 for milk powder, and 1,248 for cocoa butter, balanced between uncontaminated controls and samples spiked with 1.0 ppm MOAH standards using one-step methanol dilution. Seven algorithms (Random Forest, SVM, KNN, Gradient Boosting, Logistic Regression, LDA, CART) were trained and externally validated with diesel oil–contaminated samples (0.1–5.0 ppm) and non-contaminated samples.

Logistic Regression achieved 100% accuracy for sunflower oil, KNN for milk powder, and Random Forest for cocoa butter. High sensitivity and specificity across matrices demonstrate robustness. This approach shows strong potential for rapid, cost-effective routine screening of MOAH in food materials, with opportunities for further optimization and scalability.

Funding acknowledgements: *This project is funded by the MARS Global Food Safety Center*

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