Fast Gas Chromatography – Ion Mobility Spectrometry (GC – IMS) for Authenticating Geographical Provenance and Detecting Adulteration of Palm Oil

Kirstie A Goggin[1], Emma Brodrick[2], Antony N Davies[1,3] and Denis J Murphy[1]

University of South Wales
Prifysgol De Cymru

Background

60 million tonnes of palm oils were consumed globally in 2016/17 [1] and they are said to be present in 50% of UK supermarket products [2]. However, the palm oil industry is associated by some consumers, manufacturers and lobby groups as having negative impacts on the environment and its associated communities. Subsequently, there is an ever increasing demand for improved *traceability*, *sustainability* and *authenticity* within vegetable oil supply chains:

- *Traceability* – the ability to trace a commodity from production to distribution [3]
- *Sustainability* – development that meets the need of the present without compromising the ability of future generations to meet their own needs
- *Authenticity* – as being as described on the label

Current controls are based on potentially fallible audits, thus there is an urgent demand for robust analytical methods to accompany administrative controls [4]. This study assess the use of GC-IMS for authenticating geographical origin of palm oil and for detection of adulteration.

Methods

Volatile Organic Compound (VOC) analysis performed with a FlavourSpec©, using optimized methods for crude palm oil (Figure 1):

- Samples melted in agitated water bath at 275 rpm and 45°C for 15 min
- 1g weighed and pipetted into 20 mL headspace vial
- Samples pre-conditioned in autosampler at 60°C for 15 min
- GC-IMS analysis for 16 min
- Results analysed using in-house software (Principal Components Analysis (PCA)).

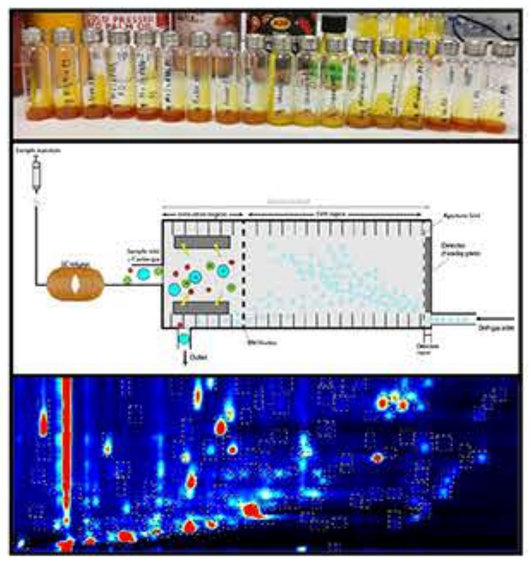

Figure 1. Process of analysis (top, melt palm oil and place in vials; middle, run on GC-IMS; bottom, generate spectra)

Findings

Geographical Origin

40 samples from four mills across four regions of Malaysia collected and analysed, PCA then applied (Figure 2):

- Samples from Mill 3 successfully grouped (Mill 3 process fruits from a *single* source)
- No apparent grouping of samples from Mill 1, 2 and 4 (Mills process fruit from *multiple* sources)

Processing fruits from multiple sources introduces variation (environmental conditions, oil palm variety, etc.) potentially leading to inability to classify by origin, using PCA alone. Application of advanced chemometrics for classification not possible due to small and limited sample size.

Adulterant Detection

Two adulterants added to crude palm oil in different concentrations (Figure 3):

- C1 (palm fibre oil) - *indistinguishable from control*
- C2 (sludge palm oil) - *detection at 1% within 4 mins*

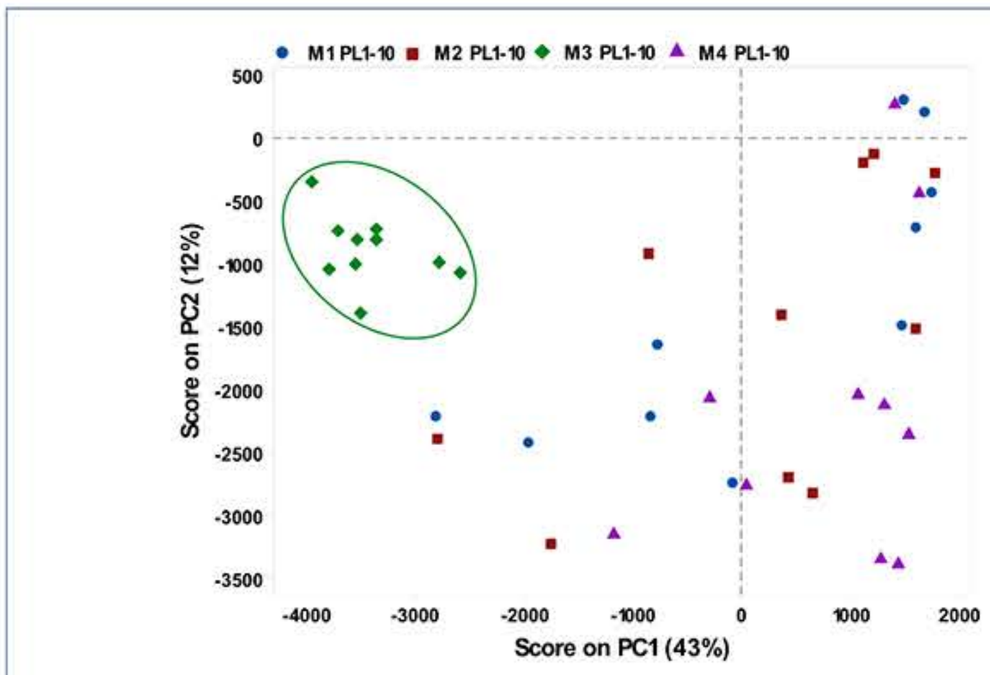

Figure 2. PCA plot showing grouping of samples according to geographical origin of each mill.

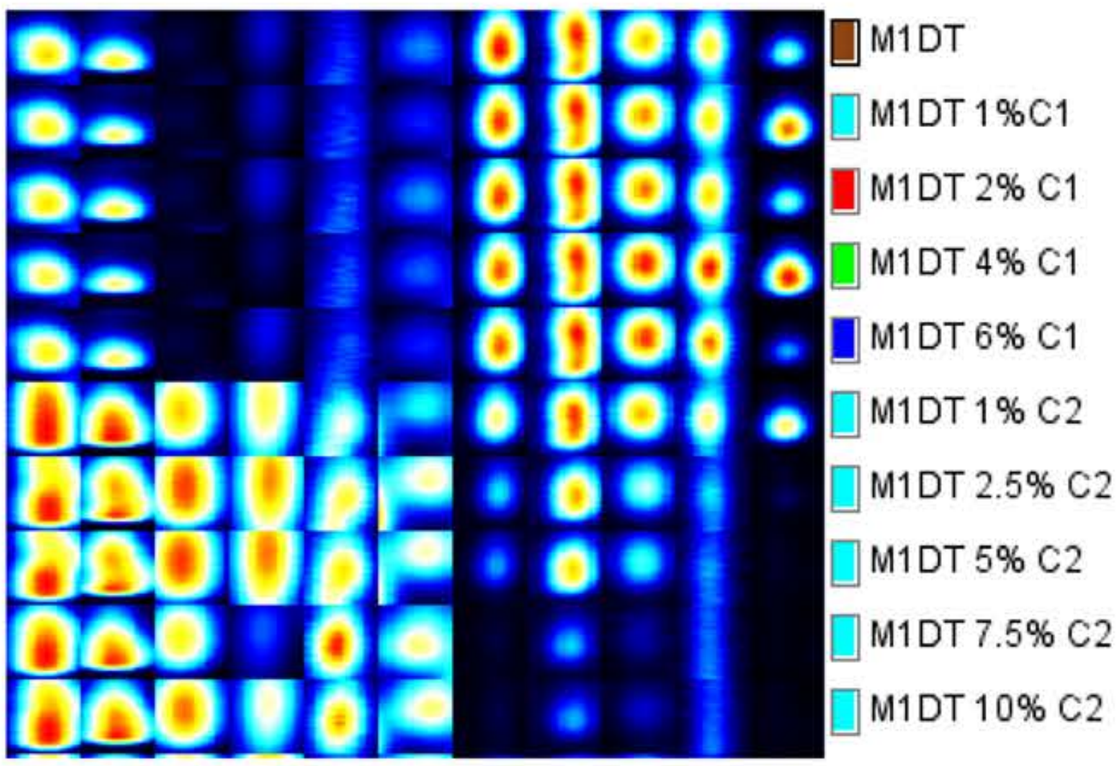

Figure 3. Gallery plot of manually selected peaks highlighting similarities and differences between control and adulterated samples.

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Author Information

Please forward any queries to Professor Denis J Murphy
denis.murphy@southwales.ac.uk

Author Affiliations:
[1]University of South Wales, Pontypridd, UK
[2]IMSPEX Diagnostics, Abercynon, UK
[3]AkzoNobel Chemicals, Deventer, NL

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