

## Nuclear and complementary field deployable technologies to build food authenticity capability

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### Food and Environmental Protection Section and Laboratory

- International Standards (Codex, safety, quality, trade)
  - > Food safety, and quality to enhance international trade.
  - > Help establish food monitoring programmes and self-sustaining networks.

#### • Analytical technology development (applied research, analytical support & training)

- Agrochemical residues
- Veterinary drug residues
- > Naturally occurring toxins
- Heavy/toxic metals
- Food authenticity
- Traceability (food origin)
- Food irradiation
  - Food Processing
  - Phytosanitary Treatments
- Emergency response
  - Rapid response to radiological emergencies













## Nuclear techniques in Food Authenticity and origin analysis

- Stable isotope analysis (SIA) by IRMS (CRDS)
- Trace elements (TE) by EDXRF and NAA
- Volatile Organic Compound profiling (VOC) HSGC-IMS

## **Complementary techniques**

- Metabolomics by HRMS
- Targeted LC-MS and GC-MS
- Rapid untargeted screening by NIR, Raman, FT-IR, LF-NMR spectroscopies



#### OREGANO Authenticity: Method development on portable NIR device - SCiO<sup>™</sup>



# CRP D52040: Testing SCiO<sup>™</sup> model transferability





- 34 SCiO<sup>™</sup> instruments acquired
- 32 participants globally
  - Representing 22 countries
- 6 samples
  - ➤ 2 authentic
  - 4 adulterated



# CRP D5204O: Summary of SCiO<sup>™</sup> Results

- 33/34 portable devices were able to classify correctly 5/6 samples
- Best results obtained for samples to be processed externally using SIMCA 15 software
- All adulterated samples were correctly identified
- One sample was consistently an outlier for unknowns reasons.
- This study has, for the first time, examined the ability to use a low-cost field deployable NIR device coupled to chemometrics, across five continents, to detect adulterated food.





### **CRP D52040: Project Output**

Food Chemistry 353 (2021) 128718

Contents lists available at ScienceDirect Food Chemistry journal homepage: www.elsevier.com/locate/foodchem

The potential of handheld near infrared spectroscopy to detect food adulteration: Results of a global, multi-instrument inter-laboratory study

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ARTICLE INFO

#### ABSTRACT

Keywords: Portable near infrared spectroscopy Chemometric models Discriminant analysis Food adulteration testing Global Inter-laboratory study Herbs and spices Oregano adulteration Fraud in the food supply system will be exacerbated by shortages caused by climate change and COVID-19's impact. The dried herbs market exemplifies complex supply chains attractive to criminals seeking financial gain. Real-time remote testing is achievable through development of globally accessible chemometric models for portable near infrared devices, deployed throughout supply chains. This study describes building of models for detection of oregano adulteration, on portable near infrared devices, and comparison to a laboratory-based Fourier-Transform Infrared spectroscopy method. 33/34 portable devices were able to correctly classify 5 out of 6 samples successfully with all adulterated samples being correctly classified following the use of appropriate transferability pre-processing routines. The devices native setup shows limited ability to perform a true screening of oregano using the setup offered. However modifications to the setup could in the future offer a solution that facilitates fit-for-purpose real time detection of adulterated samples within the supply chain.

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## **CRP D52040: Argan oil Authenticity**

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- Morocco's exports of argan oil have more than doubled in the past five years, to more than 700 tons
  - The Moroccan government plans to regenerate 200,000 hectares of Argan forest, create a new chain of modern Argan farms, and increase production to 10,000 tons.
  - 150, mostly female run, local co-operatives with the most successful generating sales of around \$650,000 annually
  - Over 20 million workdays are generated by the various aspects of the process of which 7.5 million involve the extraction of the oil, a task primarily accomplished by women

#### CRP D52040: ARGAN OIL AUTHENTICITY HEAD-SPACE GAS CHROMATOGRAPHY – ION MOBILITY SPECTROMETRY







2 DIMENSIONS OF SEPARATION HIGH SENSITIVITY (LOW PPB RANGE)







### Authenticity screening of argan oil

- Fatty Acid Composition by 1H NMR multiple linear regression method
- Gives fatty acid composition values consistent with the literature
- Works well for detecting gross adulteration with many oils
- Not able to detect presence of oils with very similar MUFA/PUFA profiles e.g. rice bran oil



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## **CRP D52040: Project Output**



## EXAMPLE TC Project – Malaysia Rapid screening method applications







Contents lists available at ScienceDirect

Forensic Chemistry

journal homepage: www.elsevier.com/locate/forc



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## CRP D52040: Success story - China CAAS IQSTAP collaborating with Yili



Collaboration with Yili group; a large milk processing company, to promote and implement portable NIR testing of raw milk for the presence of adulterants such as urea









Check for updates

Stable isotope analysis of non-exchangeable hydrogen in carbohydrates derivatised with *N*-methyl-bis-trifluoroacetamide by gas chromatography – Chromium silver reduction/High temperature Conversion-isotope ratio mass spectrometry (GC-CrAg/HTC-IRMS)

Aiman Abrahim, Andrew Cannavan, Simon D. Kelly\*



Plot of authentic pineapple juice sucrose-TFA derivative  $\delta^2$ H values versus bulk pineapple sugar  $\delta^{13}$ C and beet and cane sucrose-TFA derivative  $\delta^2$ H and bulk  $\delta^{13}$ C with 95% Prediction ellipses



#### **BEET, CANE AND AUTHENTIC PINEAPPLE SUGAR (SUCROSE)**





Check for updates

### ARTICLE OPEN Detection of exogenous sugars in pineapple juice using compound-specific stable hydrogen isotope analysis

Simon D. Kelly <sup>[b]</sup><sup>™</sup>, Aiman Abrahim <sup>[b]</sup>, Peter Rinke <sup>[b]</sup> and Andrew Cannavan <sup>[b]</sup>

An improved procedure for determining <sup>2</sup>H/<sup>1</sup>H isotope ratios, using gas chromatography-isotope ratio mass spectrometry, has been used to detect the addition of exogenous C4-plant-derived sugars to pineapple juice. Isotopic techniques are commonly used to identify the addition of low-cost sugars to fruit juices and are difficult to subvert as it is not economically viable to change the isotopic ratios of the sugars. However, the addition of cane sugar to pineapple juice has presented a significant challenge that is only detected by site-specific <sup>13</sup>C analysis of the methyl and methylene positions of ethanol derived from pineapple sugars, measured by nuclear magnetic resonance. This new GC-IRMS-based procedure utilises the trifluoroacetate derivative of sucrose to allow direct measurement of the carbon-bound non-exchangeable hydrogen. This provides advantages over alternative isotopic isotopic isotopic is the potential to reliably differentiate the terms of analysis time and sensitivity. This feasibility study has demonstrated the potential to reliably differentiate

## Conclusions



- Point of use, field deployable technologies have an important role to play in increasing accessibility to screening tools for food for adulterants and contaminants
- Uptake is hampered by a lack shared open access curated spectral databases of authentic products
- There is a lack of method validation and standardisation
- There is also a need for standardised guidelines when using multivariate data analysis tools especially in enforcement work



## THANK YOU FOR YOUR ATTENTION!

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