

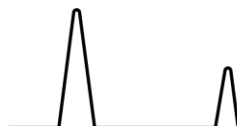


Unveil the MOSH & MOAH dimensionality by multidimensional chromatographic techniques

Giorgia Purcaro, Aleksandra Gorska, Paula Albendea

Gembloux Agro Bio-Tech, University of Liège, Belgium

gpurcaro@uliege.be





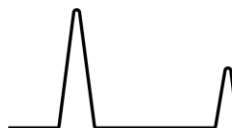
Unveil the MOSH & MOAH dimensionality by multidimensional chromatographic techniques

A GAC perspective

Giorgia Purcaro, Aleksandra Gorska, Paula Albendea

Gembloux Agro Bio-Tech, University of Liège, Belgium

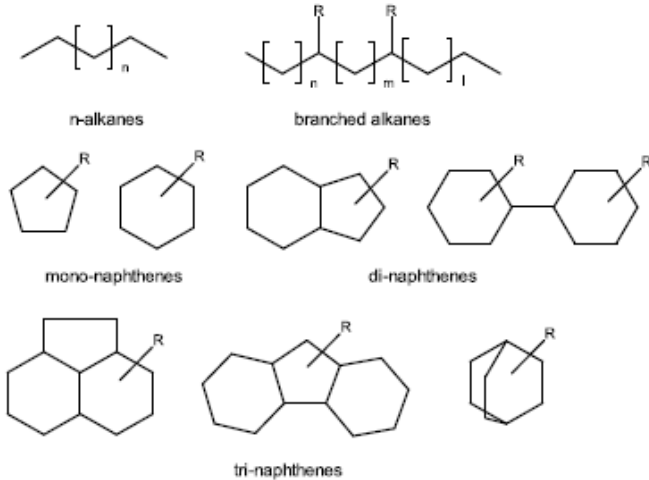
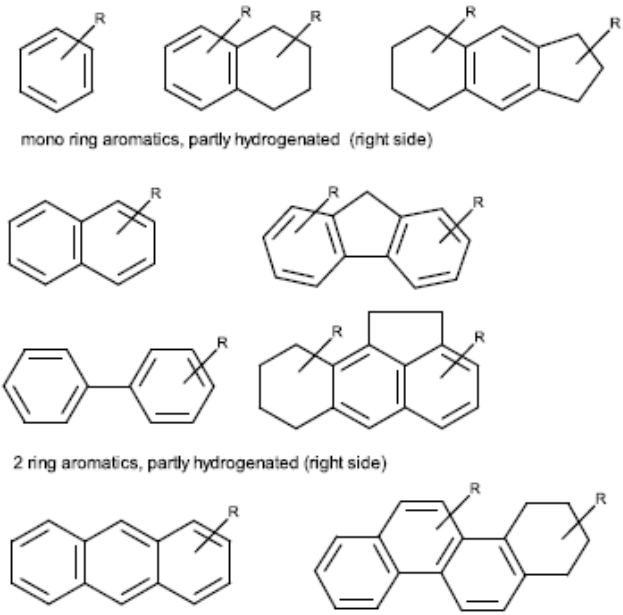
gpurcaro@uliege.be



MINERAL OIL HYDROCARBONS (MOH): DEFINITION*

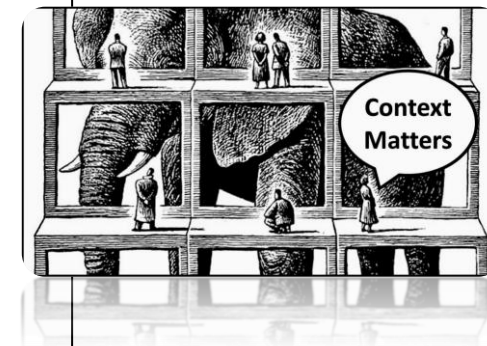
a wide range of products deriving from petroleum distillation fractions



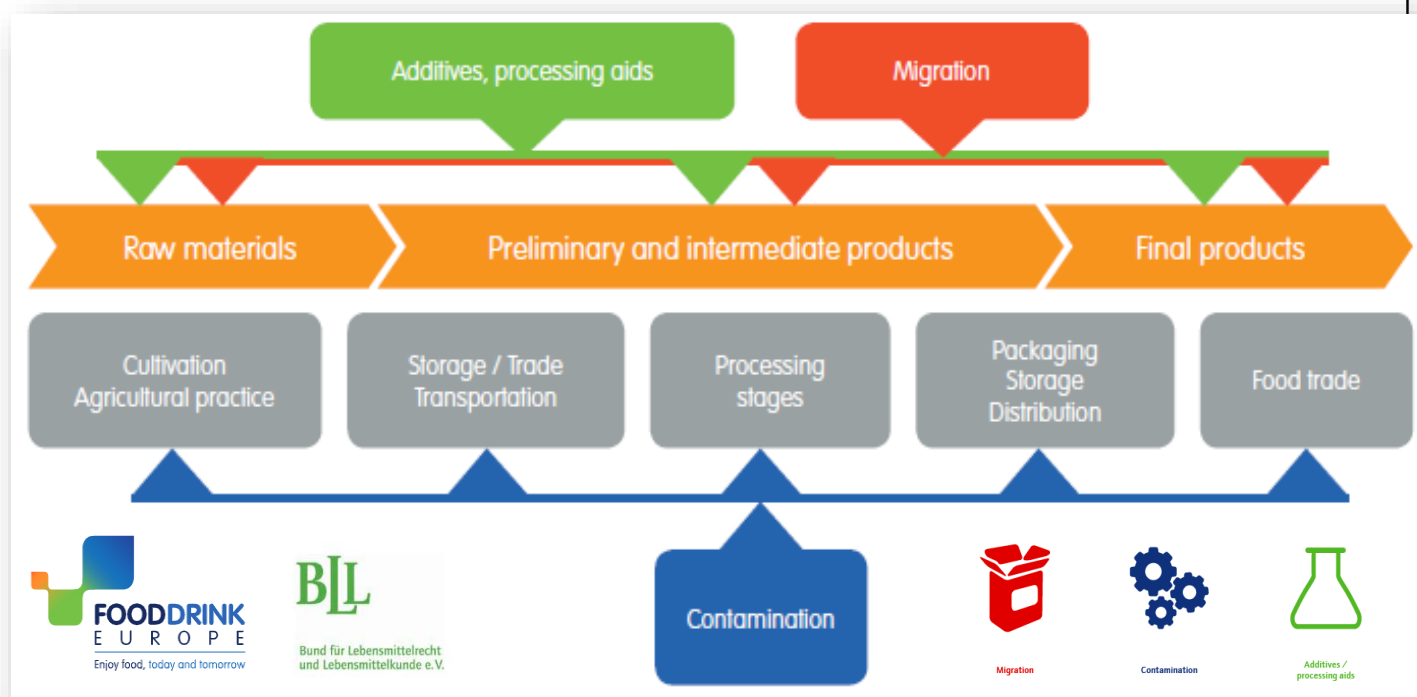
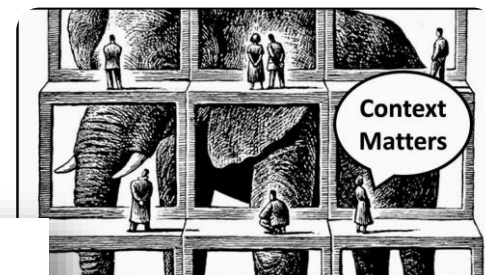
MOSH Mineral oil saturated hydrocarbons	MOAH Mineral oil aromatic hydrocarbons
 n-alkanes branched alkanes mono-naphthenes di-naphthenes tri-naphthenes	 mono ring aromatics, partly hydrogenated (right side) 2 ring aromatics, partly hydrogenated (right side) 3 ring aromatics, partly hydrogenated (right side)

-n-alkane
- isoalkane
- cycloalkane

Aromatic hydrocarbons, mainly alkylated



MINERAL OIL HYDROCARBONS (MOH): OCCURENCE



MOSH & MOAH: STATE-OF-THE ART



- Generally considered of **no concern** at the concentration found.

- **genotoxicity of MOAH with ≥ 3 aromatic rings**
- in the absence of reliable toxicity data, the dietary exposure to **1–2 ring MOAH might raise a concern**



MINERAL OIL HYDROCARBONS (MOH)

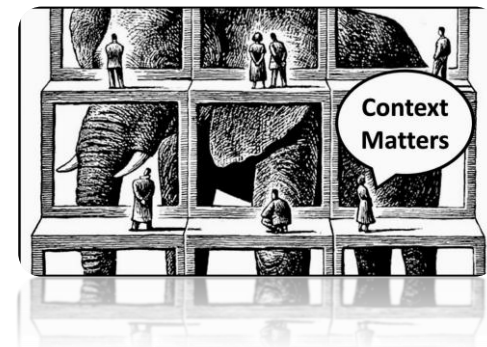


EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR HEALTH AND FOOD SAFETY

Directorate E – Food and Feed Safety, Innovation
E2 – Food processing technologies and novel foods

Information document on the ongoing discussions in the EU on regulatory measures on mineral oil hydrocarbons in food.

- The adoption of the maximum levels and indicative levels is targeted fourth quarter of 2024/ first quarter of 2025.
- As the presence of MOAH in food is avoidable, food business operators are urged to already check their processes and ensure that the concentrations of MOSH and MOAH are below the limits of quantification, which are included in the JRC Guidance:
 - 0.5 mg/kg for dry foods with a low fat/oil content ($\leq 4\%$ fat/oil)
 - 1 mg/kg for foods with a higher fat/oil content ($> 4\%$ fat/oil, $\leq 50\%$ fat/oil)
 - 2 mg/kg for fats/ oils or foods with $> 50\%$ fat/oil



MOSH & MOAH: STATE-OF-THE ART



2012



2023



MOSH



MOAH

Generation of further data for the refinement of the risk assessment is needed

➤ **Improvement of analytical methodology**
for better characterisation of MOSH&MOAH and **consistency in reporting**

MOSH & MOAH: Analytical Determination

Historical perspective

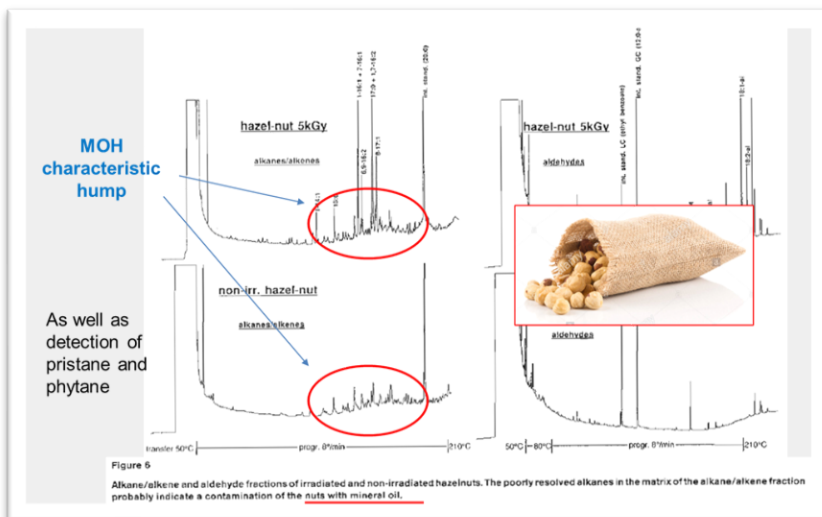


1989

J High Resol Chromatogr. 1989 12:591–598.

Partially Concurrent Eluent Evaporation with an Early Vapor Exit; Detection of Food Irradiation through Coupled LC-GC Analysis of the Fat

Maurus Biedermann, Konrad Grob*, and Werner Meier
Kantonales Labor, P. O. Box, CH-8030 Zürich, Switzerland

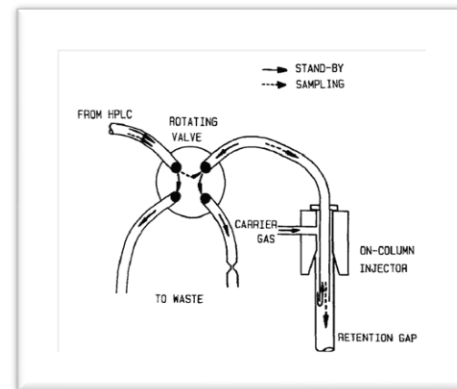


1984

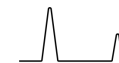
J Chromatogr. 1984 295:55-61

COUPLING OF HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY WITH CAPILLARY GAS CHROMATOGRAPHY

K. GROB, Jr.*, D. FRÖHLICH, B. SCHILLING, H. P. NEUKOM and P. NÄGELI
Kantonales Labor, P.O. Box, CH-8030 Zürich (Switzerland)



Complex applications ↔ Advanced Routine



MOSH & MOAH: Analytical Determination

LC-GC-FID

J. Agric. Food Chem. 2009, 57, 8711–8721

Aromatic Hydrocarbons of Mineral Oil Origin in Foods: Method for Determining the Total Concentration and First Results

MAURUS BIEDERMANN, KATELL FISELIER, AND KONI GROB*

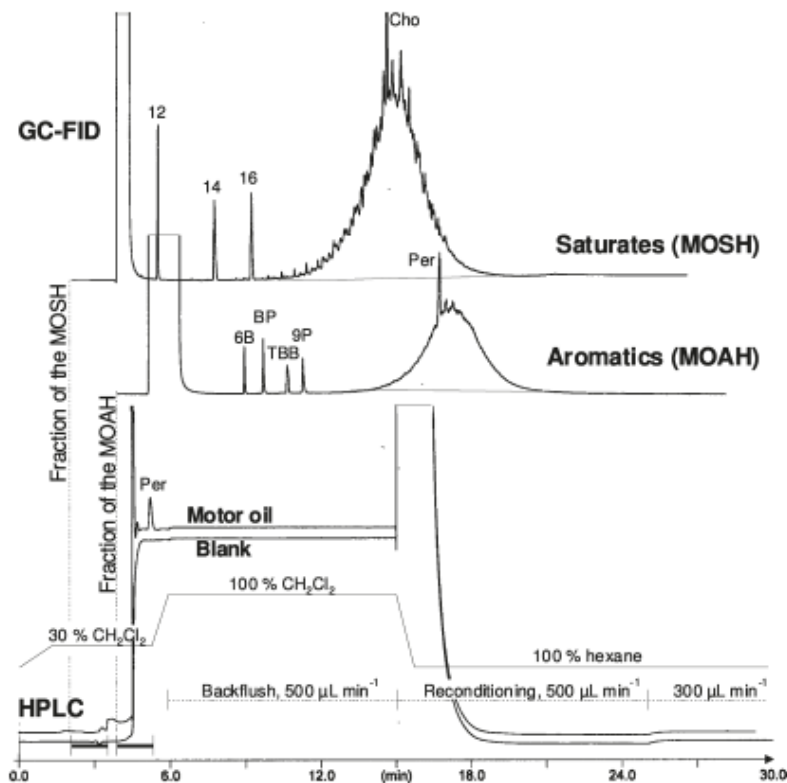
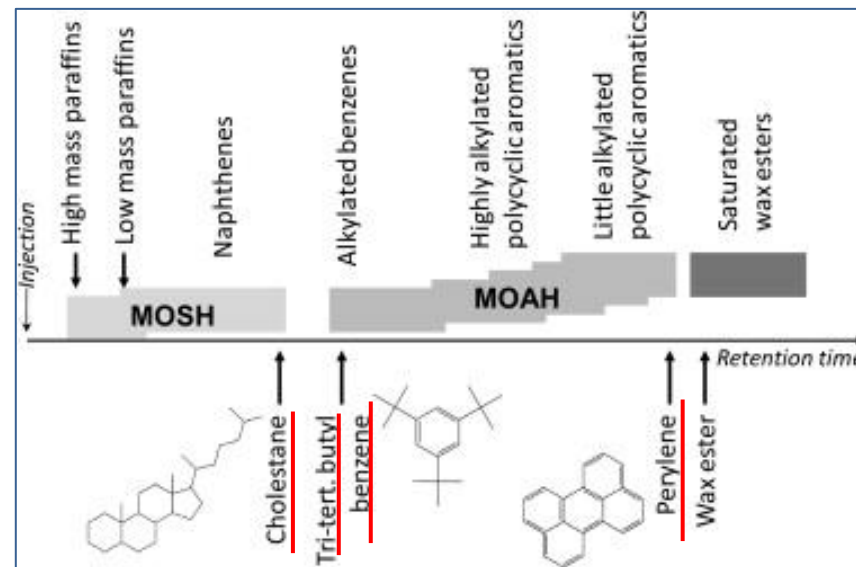


Figure 1. Analytical procedure visualized by the chromatograms of a motor (lubricating) oil. Labeled peaks indicate internal standards for determining concentrations and verification of the performance.



+ C11, C13 and CyCy (cyclohexylcyclohexane)

C11/CyCy → loss of volatiles

C13/CyCy → possible coelution

CyCy → **quantification**

+ 5B (pentyl benzene), 1MN (1-Me Na) and 2MN (2-Me Na)

5B → loss of volatiles

1MN=2MN → possible coelution/ **quantification**

MOSH & MOAH: Analytical Determination



Sample dilution (e.g., fats and oil)

LC-GC-FID

INTERNATIONAL STANDARD ISO 17780

First edition 2015-08-15

Animal and vegetable fats and oils — Determination of aliphatic hydrocarbons in vegetable oils

Cors gras d'origines animale et végétale — Détermination des hydrocarbures aliphatiques en corps gras d'origines végétale

SIST EN 16995:2017

EUROPEAN STANDARD

EN 16995

NORME EUROPÉENNE

EUROPÄISCHE NORM

June 2017

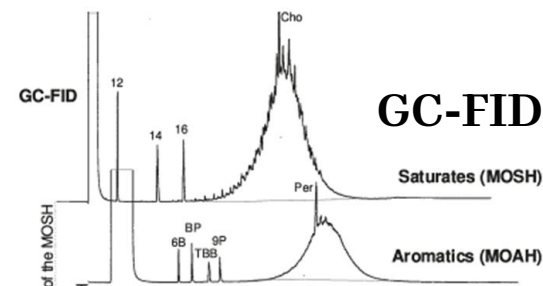
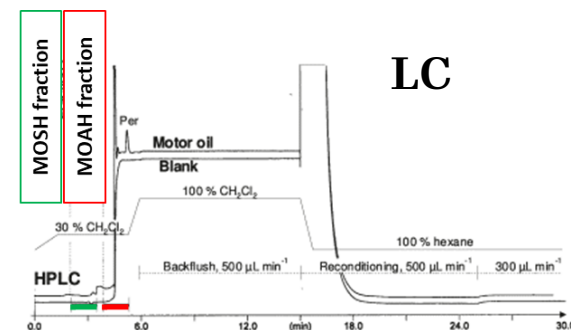
ICS 67.200.10

English Version

Foodstuffs - Vegetable oils and foodstuff on basis of vegetable oils - Determination of mineral oil saturated hydrocarbons (MOSH) and mineral oil aromatic hydrocarbons (MOAH) with on-line HPLC-GC-FID analysis

Produits alimentaires - Huiles végétales et produits alimentaires à base d'huiles végétales - Dosage des hydrocarbures saturés d'huile minérale (MOSH) et des hydrocarbures aromatiques d'huile minérale (MOAH) par analyse par CLRP-GC-FID en ligne

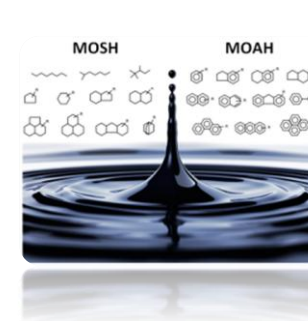
Lebensmittel - Pflanzliche Öle und Lebensmittel auf Basis pflanzlicher Öle - Bestimmung von gesättigten Mineralöl-Kohlenwasserstoffen (MOSH) und aromatischen Mineralöl-Kohlenwasserstoffen (MOAH) mit on-line HPLC-GC-FID



GREEN CHEMISTRY

GREEN ANALYTICAL CHEMISTRY

- S Select direct analytical technique
- I Integrate analytical processes and operations
- G Generate as little waste as possible
- N Never waste energy → LC-GC-FID, no MS
- I Implement automation and miniaturization → Partially Automated
- F Favor reagents from renewable sources
- I Increase safety for the operator → Online method
- C Carry out in-situ measurements
- A Avoid derivation
- N Note minimal sample number and size
- C Choose multi-analyte or multi-parameter methods → UCM
- E Eliminate or replace toxic reagents

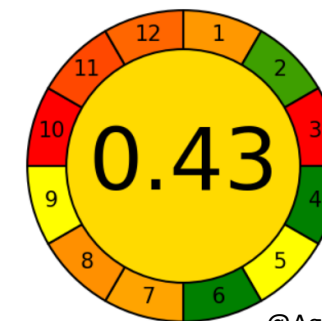
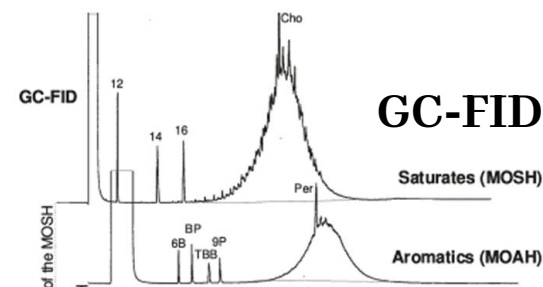
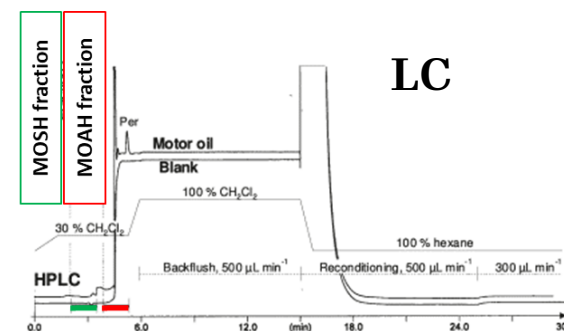
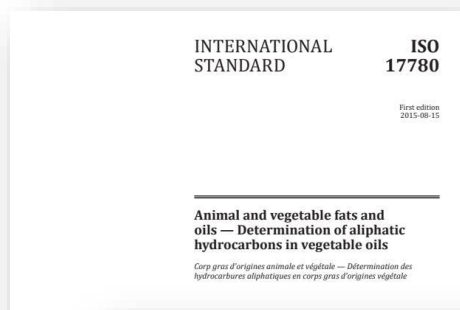


MOSH & MOAH: Analytical Determination



Sample dilution (e.g., fats and oil)

LC-GC-FID



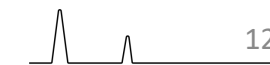
@Agree

Anal. Chem. 2020, 92, 10076–10082

- Working range starting from **10 mg/kg**
- Max LC loading : **20 mg** of fat



SENSITIVITY



12

MOSH & MOAH: Analytical Determination

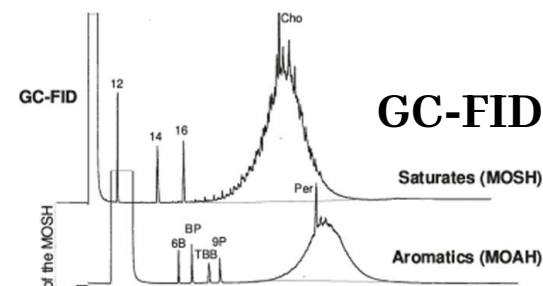
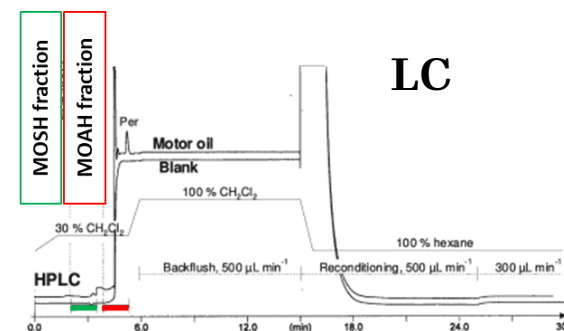


EXTRACTION/ENRICHMENT

LC-GC-FID



- ✓ Extraction and enrichment simultaneous
- ✓ higher sensitivity, less frequent washing of the LC column.
- ✓ Higher extraction yield



MOSH & MOAH: Analytical Determination

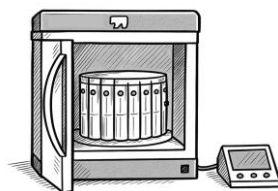


EXTRACTION/ENRICHMENT

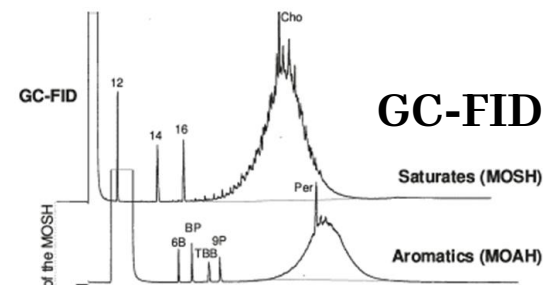
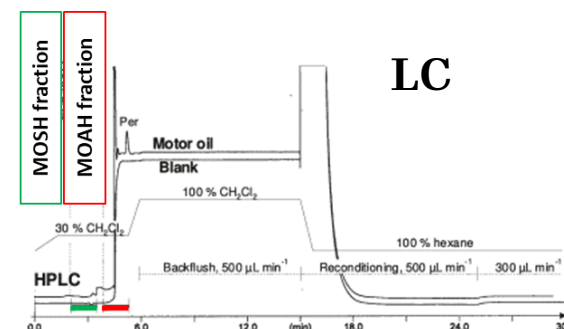
LC-GC-FID



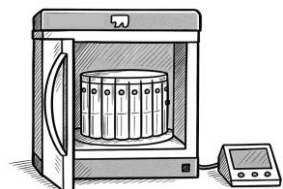
- ✓ Extraction and enrichment simultaneous
- ✓ higher sensitivity, less frequent washing of the LC column.
- ✓ Higher extraction yield



Microwave-assisted saponification and extraction (MASE) method



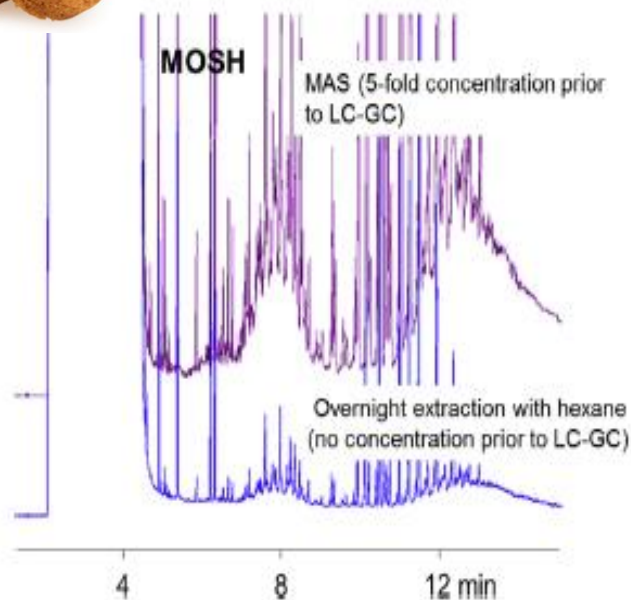
MOSH & MOAH: Analytical Determination



Microwave-assisted saponification and extraction (MASE) method

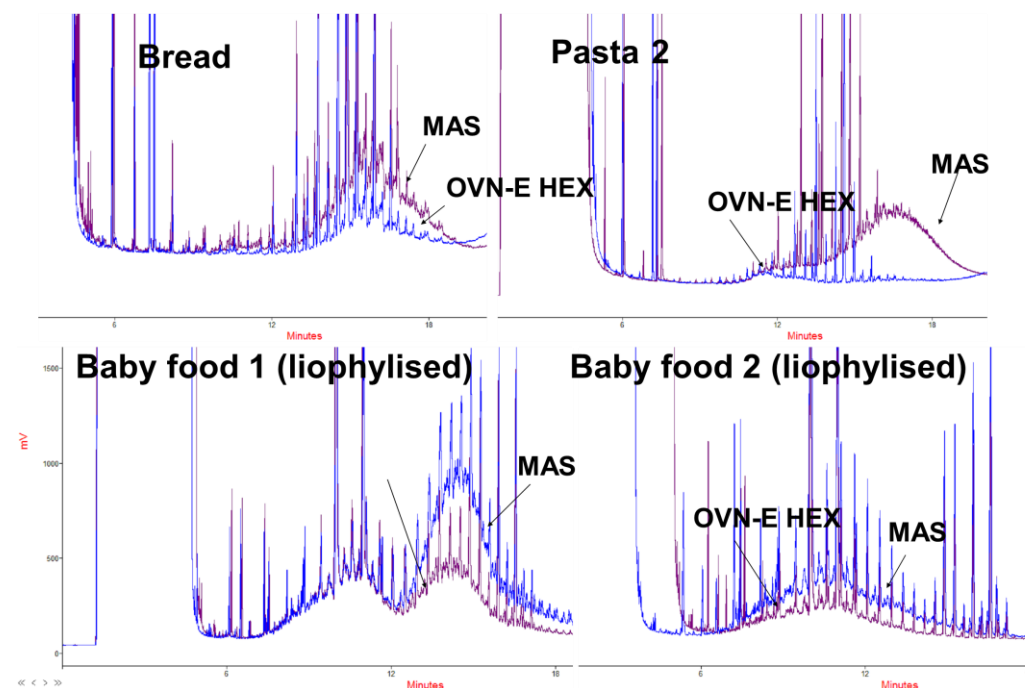


Biscuits with 25% of fat



5 × SENSITIVITY

MAS vs OVN-E (hexane)



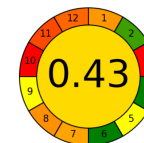
More accurate information

MOSH & MOAH: Analytical Determination



Sample dilution (e.g., fats and oil)

LC-GC-FID



- Working range starting from **10 mg/kg**
- Max LC loading : **20 mg** of fat

EXTRACTION/ENRICHMENT



LC-GC-FID



- ✓ Sensitivity (2 mg/kg*)
- ✓ Accuracy

*Depends on the initial content of fat



MOSH & MOAH: Analytical Determination

Sample dilution (e.g., fats and oil)

LC-GC-FID



EXTRACTION/ENRICHMENT

LC-GC-FID



MINIATURIZATION

- Working range starting from **10 mg/kg**
- Max LC loading : **20 mg** of fat



✓ Sensitivity (2 mg/kg*)
✓ Accuracy

*Depends on the initial content of fat

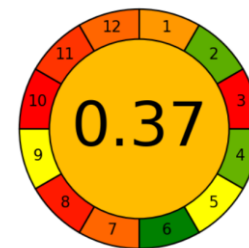
MASE applied for the meat:

5 g meat + 10 mL C6 + 10 mL KOH/(EtOH/H₂O)
MASE: 5 min pre-heating, 120 °C 20 min



MASE miniaturized:

0.4 g meat + 2.5 mL C6 + 2.5 mL KOH/(EtOH/H₂O)
MASE: 5 min pre-heating, 120 °C 20 min



Albendea P., Purcaro G., Food Chemistry 480 (2025) 143880

Albendea P., Gorska A., Purcaro G., Journal of Chromatography Open 8 (2025) 100267

Warning on representativeness!

MOSH & MOAH: Analytical Determination



EXTRACTION/ENRICHMENT

LC-GC-FID

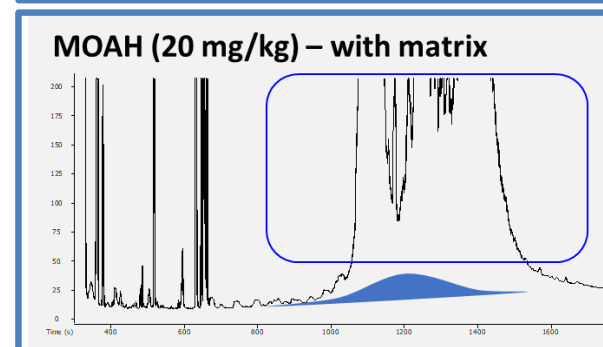
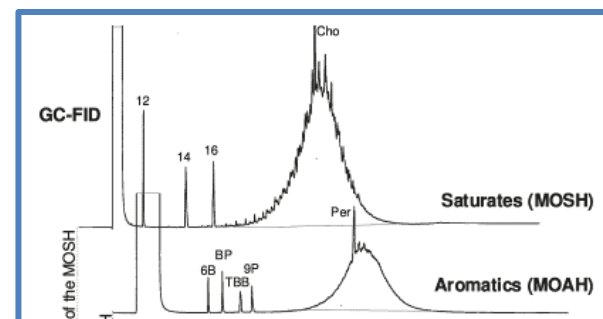


✓ Sensitivity (2 mg/kg*)
✓ Accuracy

*Depends on the initial content of fat



Microwave-assisted saponification and extraction (MASE) method

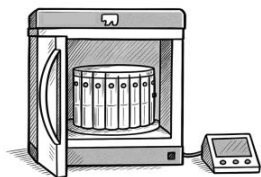


MOSH & MOAH: Analytical Determination

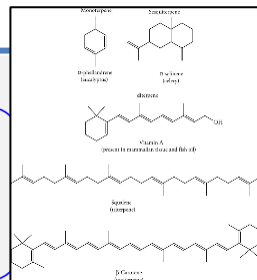
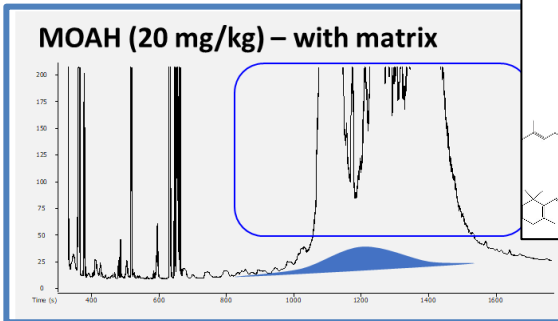
EXTRACTION/SAPONIFICATION

PURIFICATION

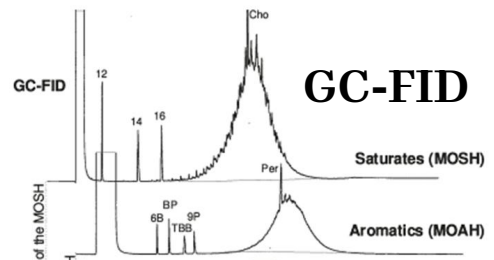
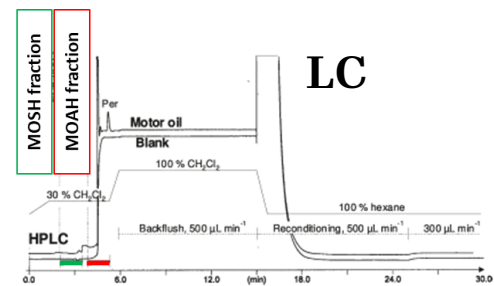
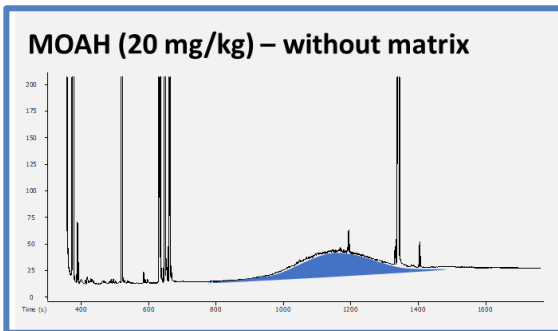
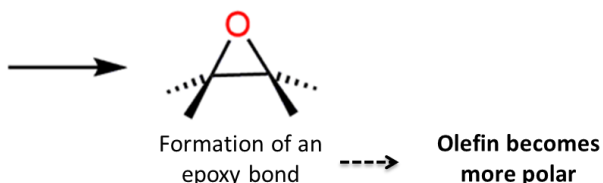
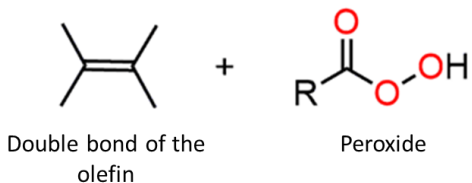
LC-GC-FID



Microwave-assisted saponification and extraction (MASE) method



EPOXIDATION



ISO 20122:2024

Vegetable oils — Determination of mineral oil saturated hydrocarbons (MOSH) and mineral oil aromatic hydrocarbons (MOAH) with online-coupled high performance liquid chromatography-gas chromatography-flame ionization detection (HPLC-GC-FID) analysis — Method for low limit of quantification

Works rather well but also **attacks** MOAH due to their double bonds



MOSH & MOAH: Analytical Determination

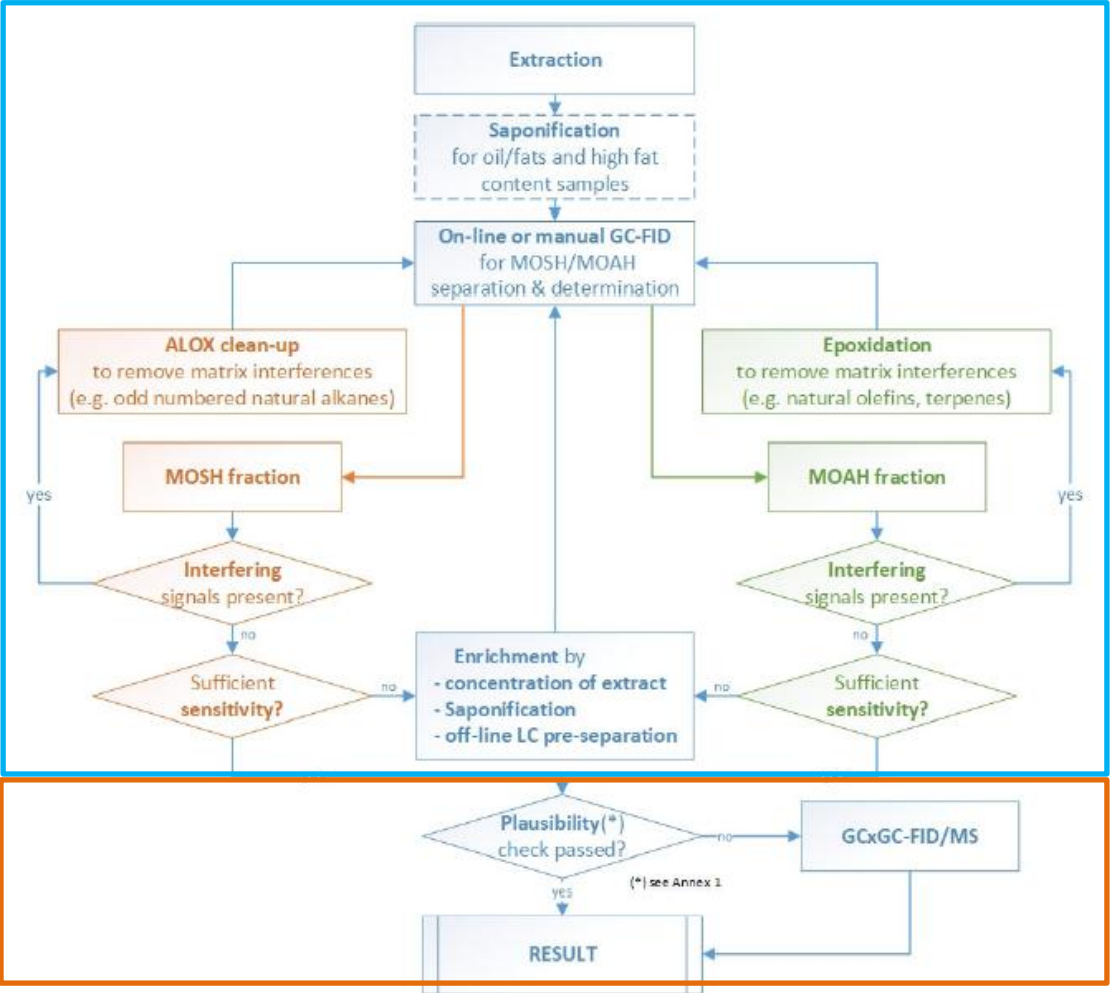


Figure 5 Decision tree on the use of auxiliary methods.

✓ Need for matrix-tailored sample prep protocols

Sample Preparation



Data Interpretation

> 20% of uncertainty!

Data Integration



JRC TECHNICAL REPORTS

Guidance on sampling, analysis and data reporting for the monitoring of mineral oil hydrocarbons in food and food contact materials - 2nd Edition

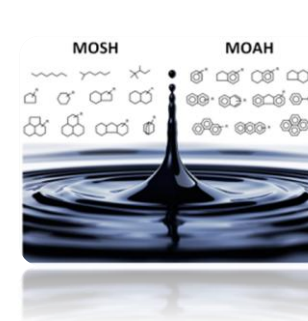
In the frame of Commission Recommendation (EU) 2017/84

S. Bratinova, P. Robouch, E. Hoekstra
2023

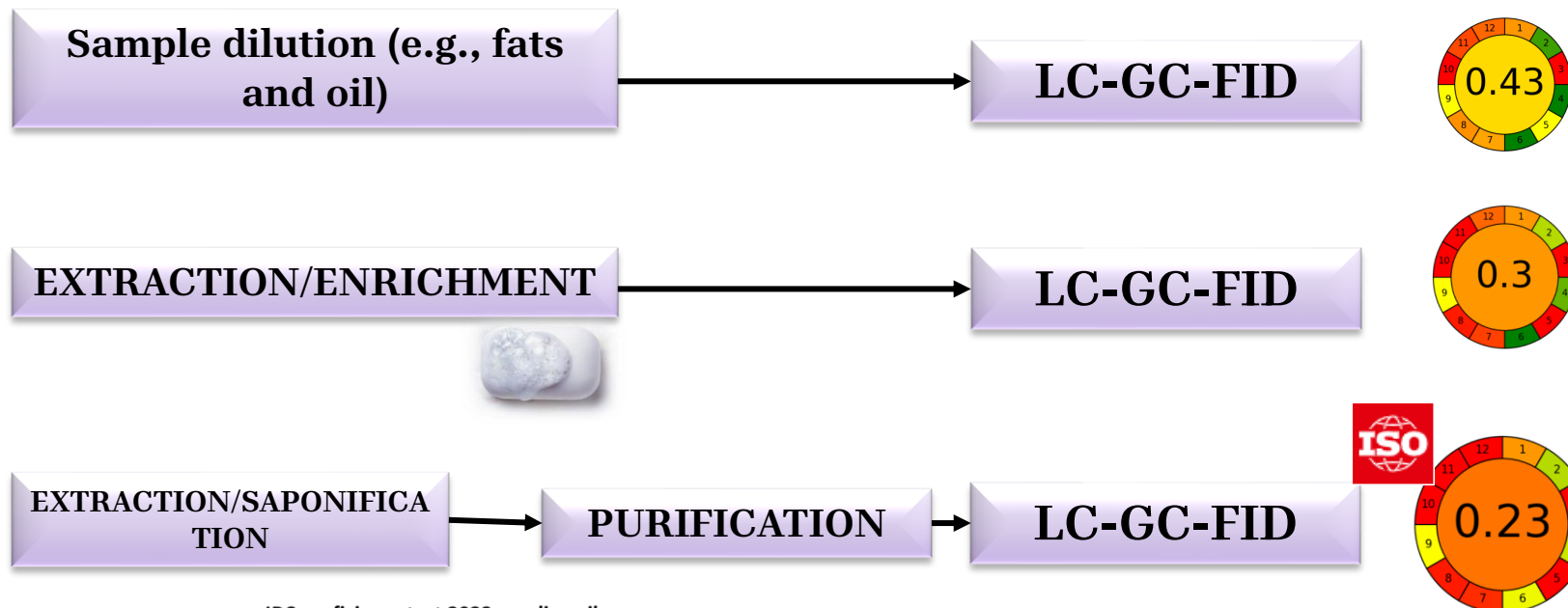
GREEN CHEMISTRY

GREEN ANALYTICAL CHEMISTRY

- S Select direct analytical technique
- I Integrate analytical processes and operations
- G Generate as little waste as possible
- N Never waste energy → LC-GC-FID, no MS
- I Implement automation and miniaturization → Partially Automated
- F Favor reagents from renewable sources
- I Increase safety for the operator → Online method
- C Carry out in-situ measurements
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- N Note minimal sample number and size
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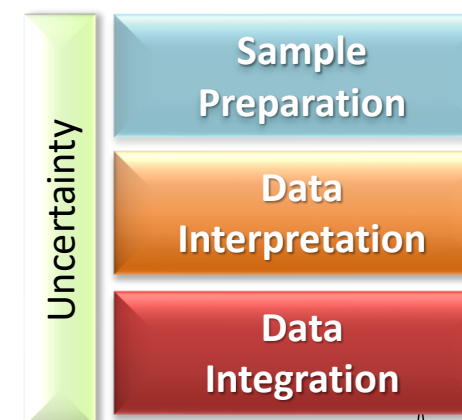
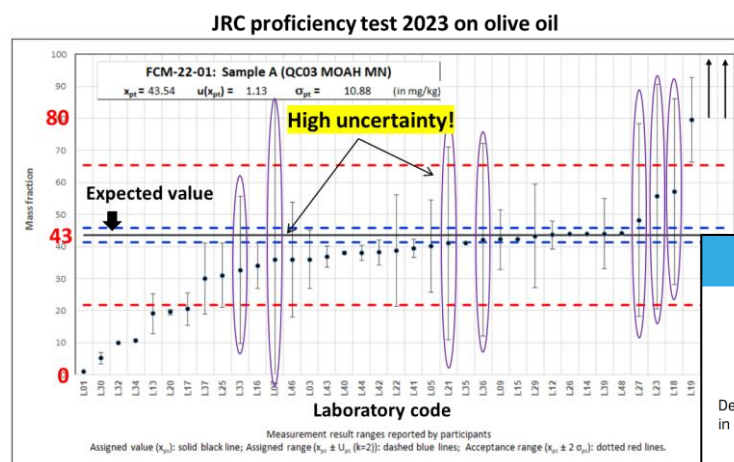
MOSH & MOAH: Analytical Determination



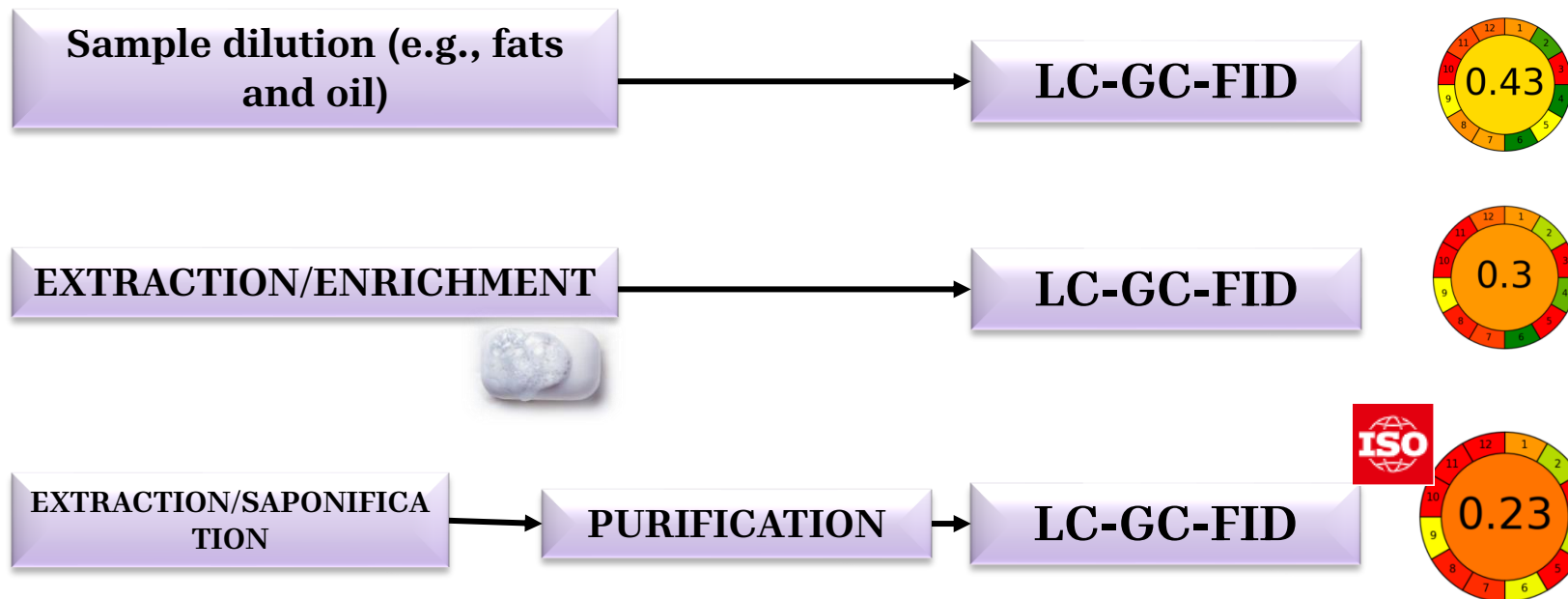
- Working range starting from **10 mg/kg**
- Max LC loading : **20 mg** of fat

↑ Sensitivity (2 mg/kg*)

*Depends on the initial content of fat



MOSH & MOAH: Analytical Determination



- Working range starting from **10 mg/kg**
- Max LC loading : **20 mg** of fat

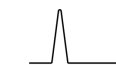


↑ Sensitivity (2 mg/kg*)

*Depends on the initial content of fat



↑ Applicability
≈ Sensitivity
≈ ↑↓ Accuracy



MOSH & MOAH: Analytical Determination

The Source of Uncertainty



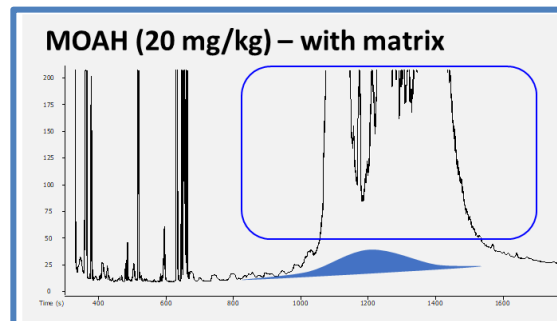
EXTRACTION/SAPONIFICATION

PURIFICATION

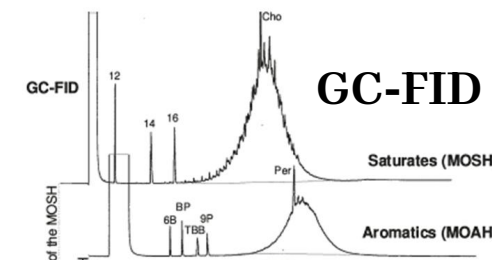
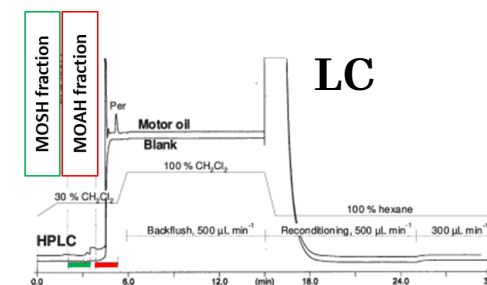
LC-GC-FID



Microwave-assisted saponification and extraction (MASE) method



Sample Preparation

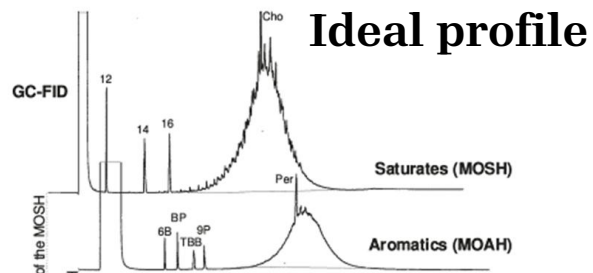
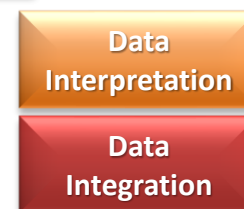


Data Interpretation

Data Integration

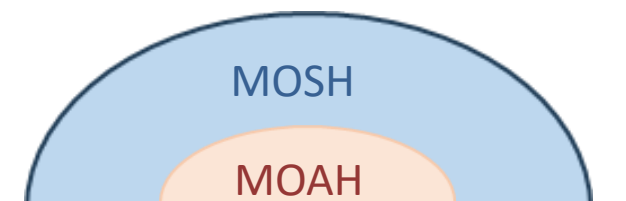


MOSH & MOAH: Analytical Determination



- ✓ NO MOAH without MOSH
- ✓ Same volatility range
- ✓ MOSH $\sim 4 \times$ MOAH

Most probably not MOAH, but interferences



MOSH & MOAH: Analytical Determination



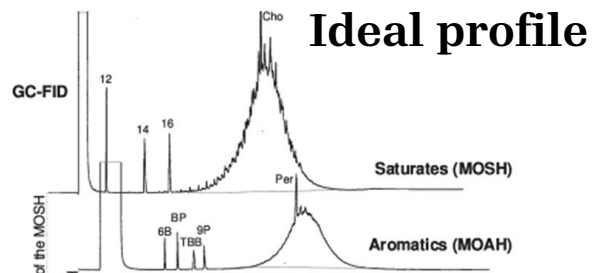
EXTRACTION/SAPONIFICATION

PURIFICATION

LC-GC-FID

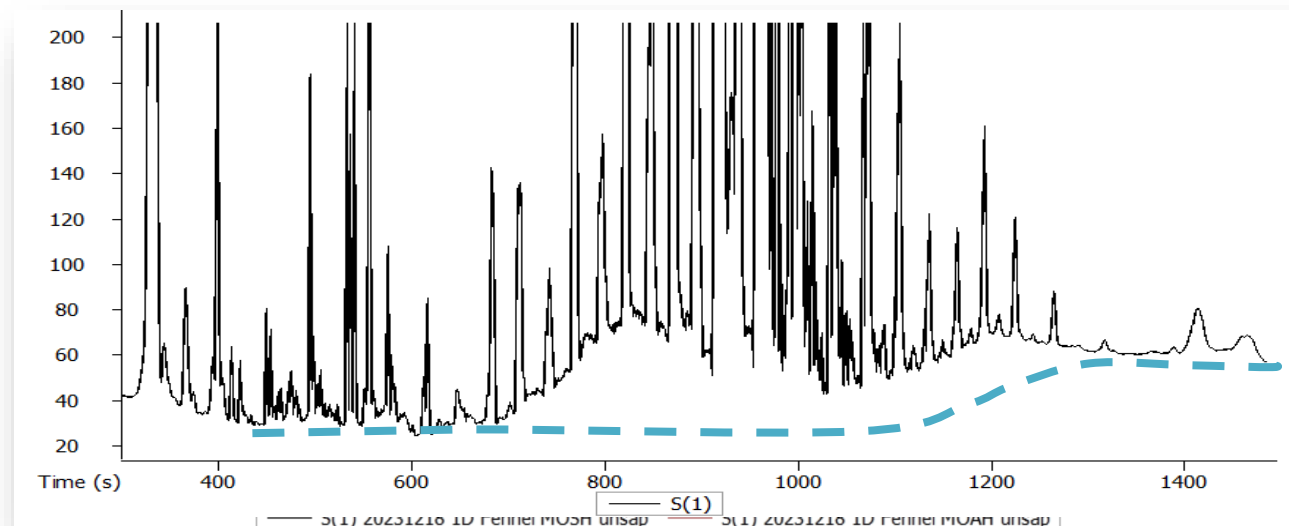
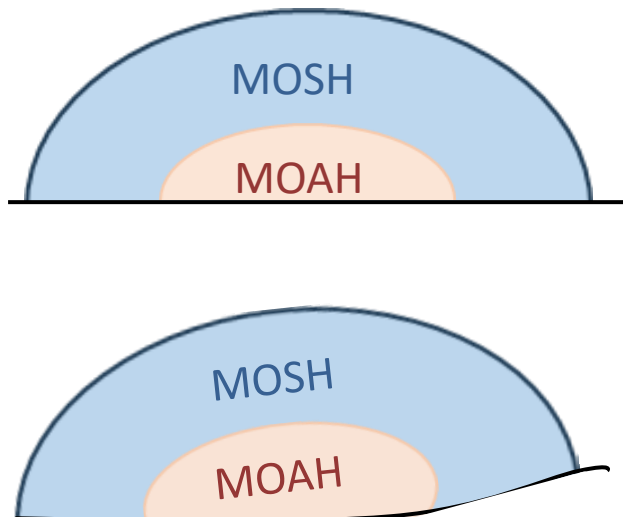
Data Interpretation

Data Integration

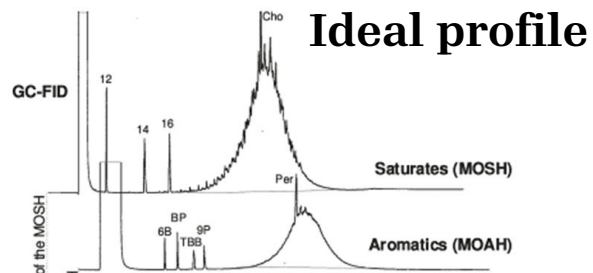


- Baseline
- Riding peaks

MOSH vs MOAH – No purification



MOSH & MOAH: Analytical Determination

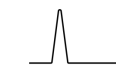
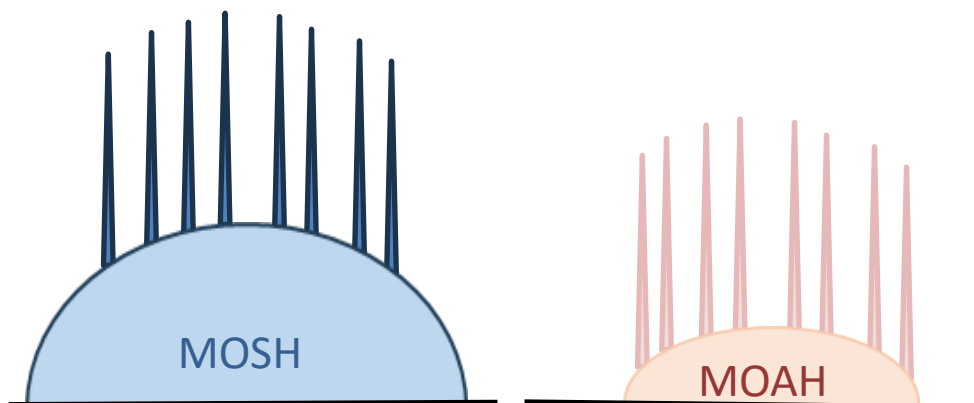


- Baseline
- Riding peaks

Data Interpretation

Data Integration

Trimming or not the riding peaks? And how?



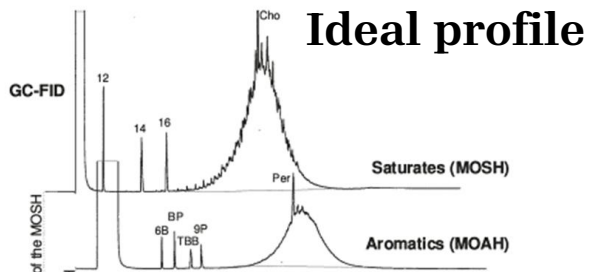
MOSH & MOAH: Analytical Determination



EXTRACTION/SAPONIFICATION

PURIFICATION

LC-GC-FID



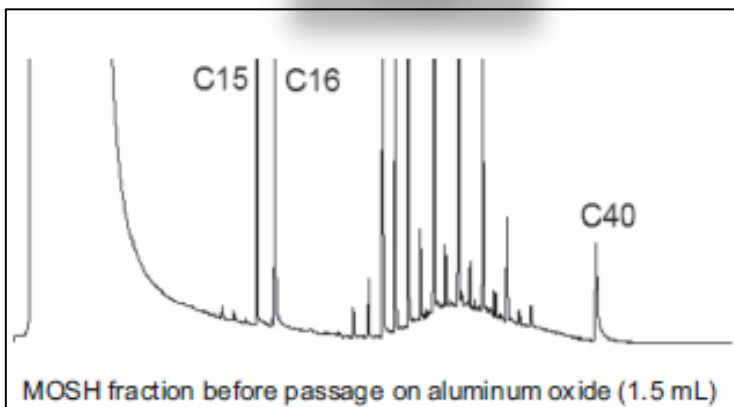
- Baseline
- Riding peaks

Data Interpretation

Data Integration

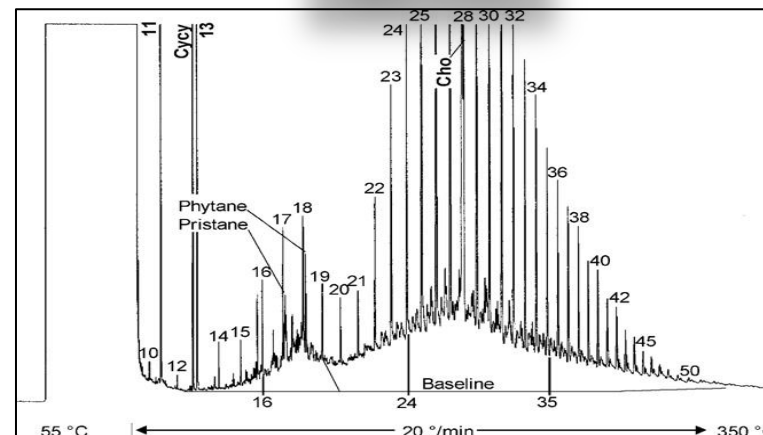
Trimming or not the riding peaks? And how?

Trim

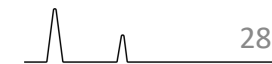


Natural alkanes: primarily odd-chain in the $\geq C_{21}$

NO Trim



MO alkanes: no prevalence

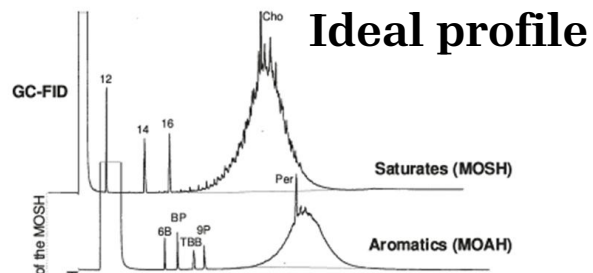


MOSH & MOAH: Analytical Determination



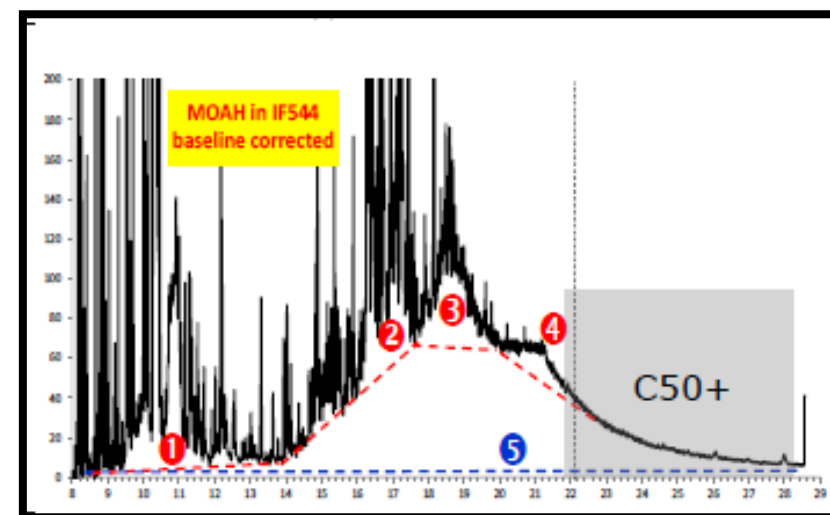
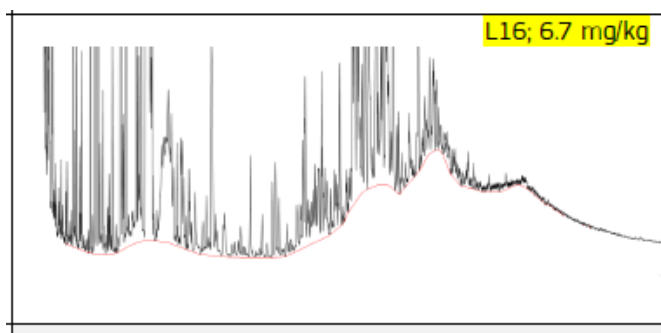
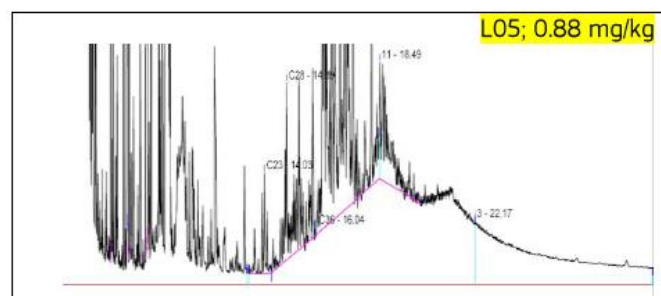
Data Interpretation

Data Integration



- Baseline
- Riding peaks

Trimming or not the riding peaks? And How?



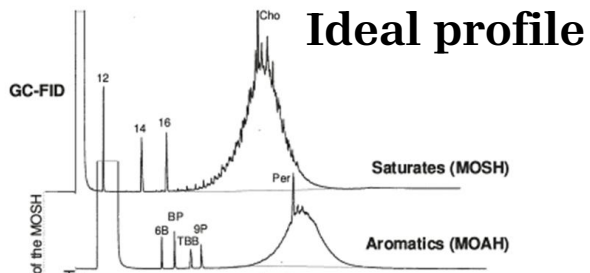
MOSH & MOAH: Analytical Determination



EXTRACTION/SAPONIFICATION

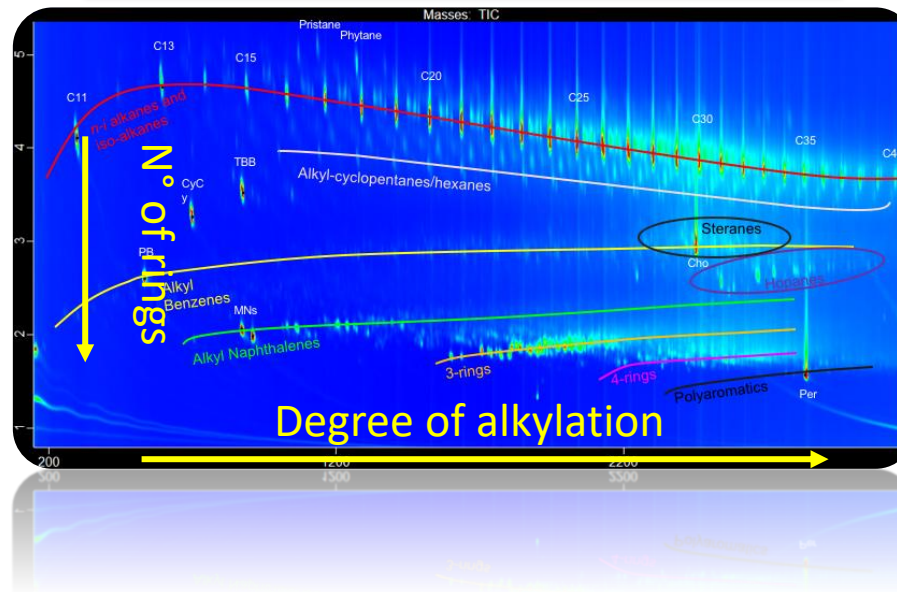
PURIFICATION

LC-GC-FID



How to support the interpretation?

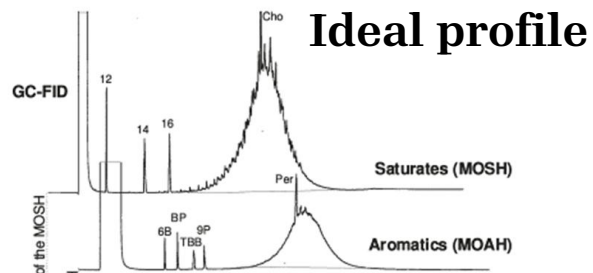
GC×GC



Data Interpretation

Data Integration

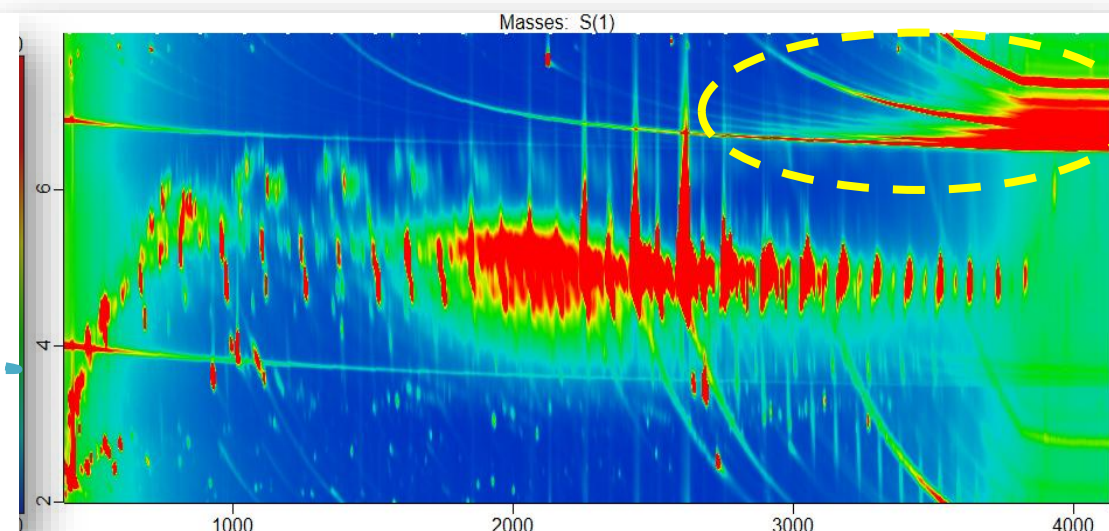
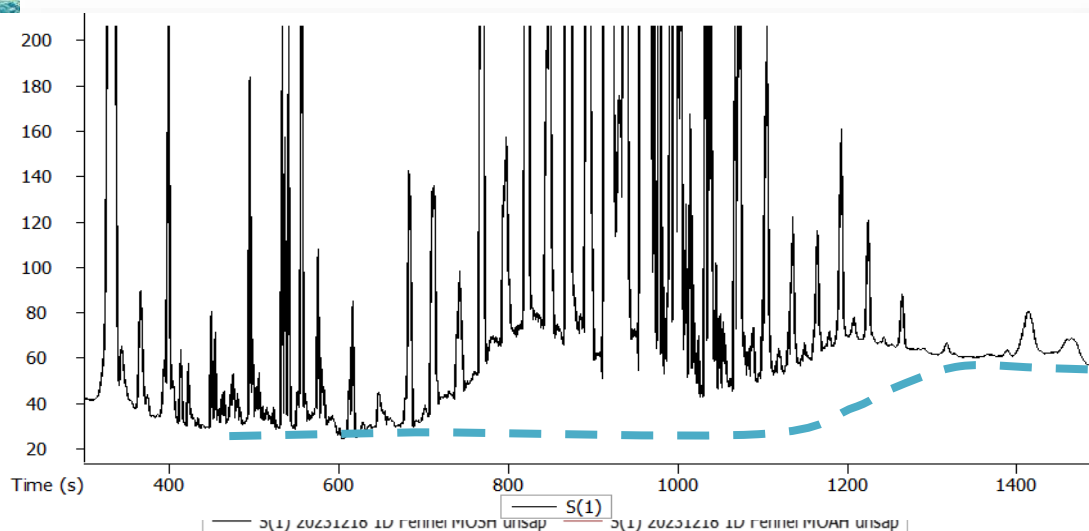
MOSH & MOAH: Analytical Determination



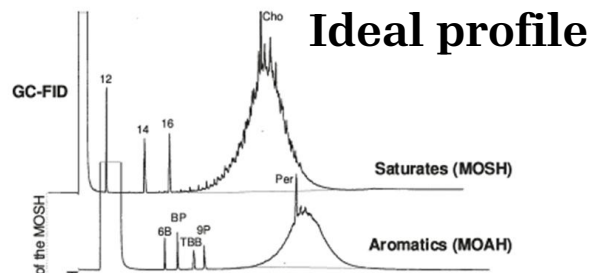
How to support the interpretation?

GC×GC

More accurate quantification



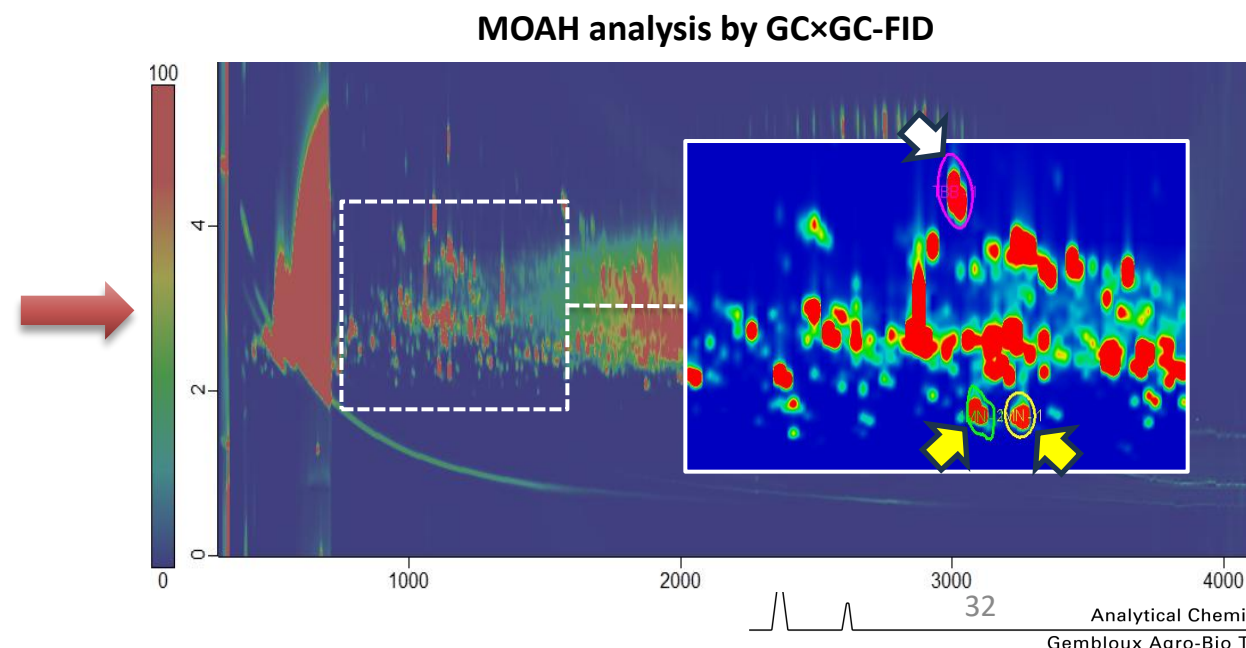
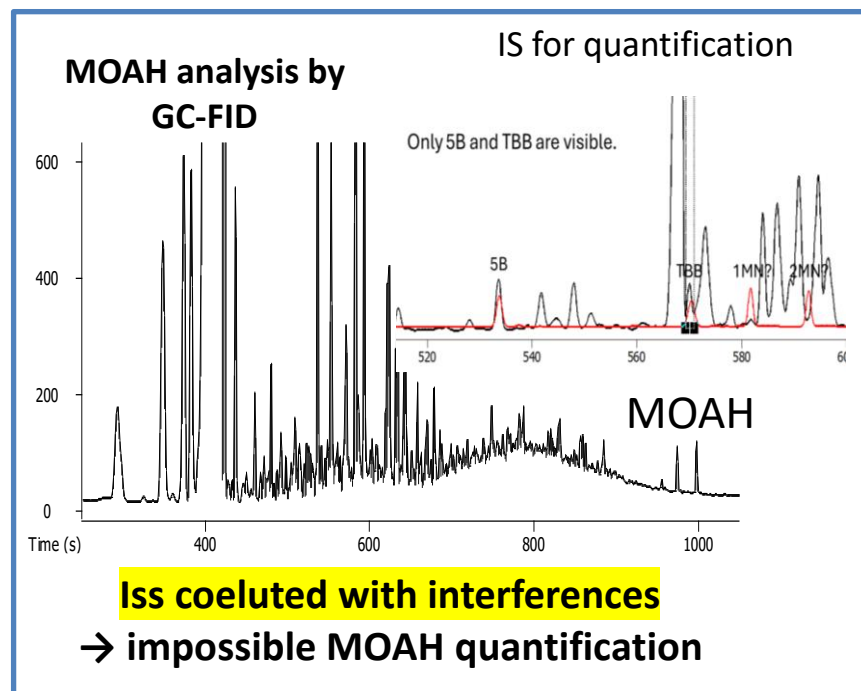
MOSH & MOAH: Analytical Determination



How to support the interpretation?

GC×GC

More accurate quantification

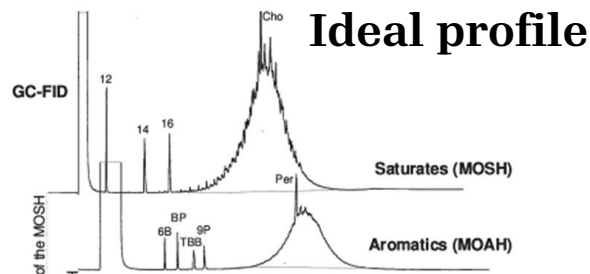


MOSH & MOAH: Analytical Determination

EXTRACTION/SAPONIFICATION

PURIFICATION

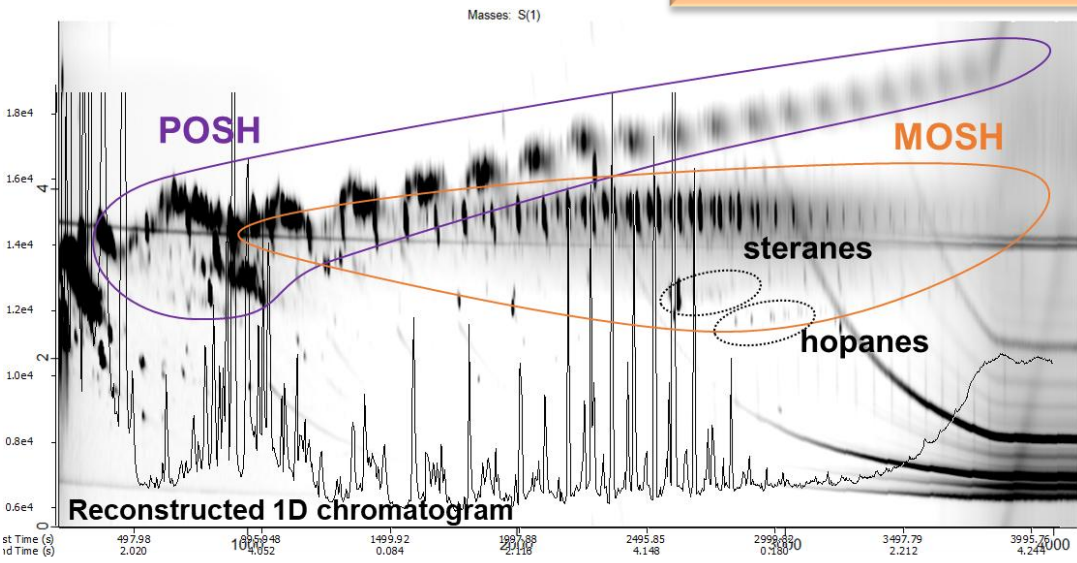
LC-GC-FID



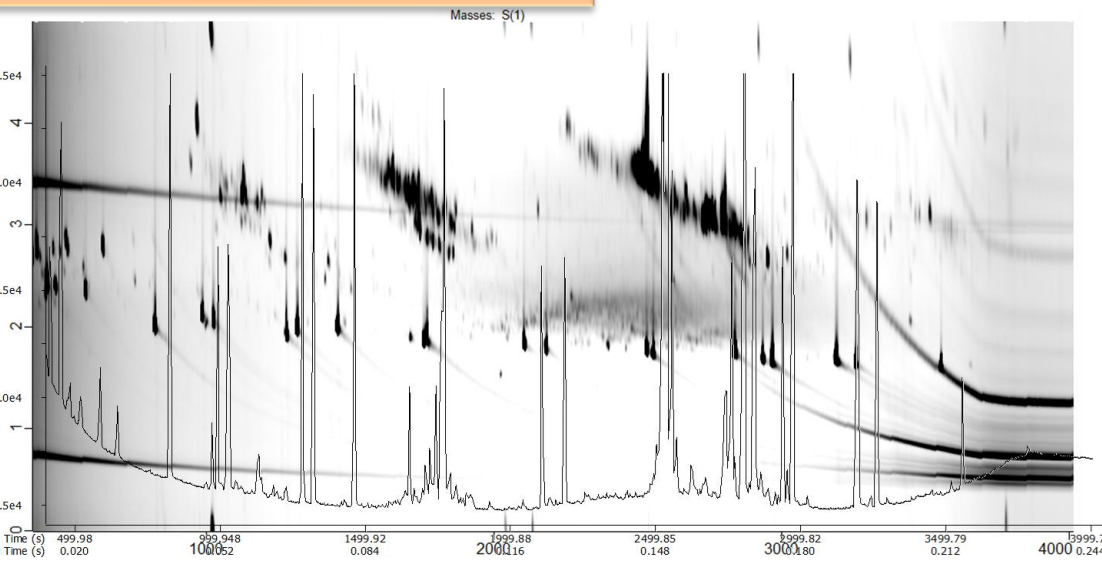
How to support the interpretation?

GC×GC

Easier interpretation



MOSH



MOAH

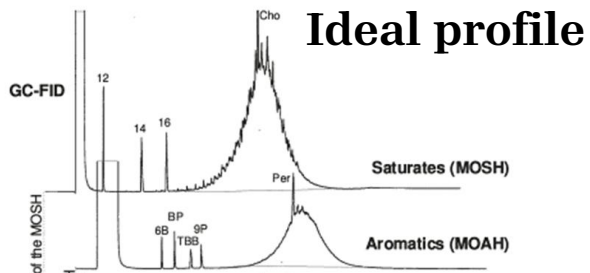
MOSH & MOAH: Analytical Determination



EXTRACTION/SAPONIFICATION

PURIFICATION

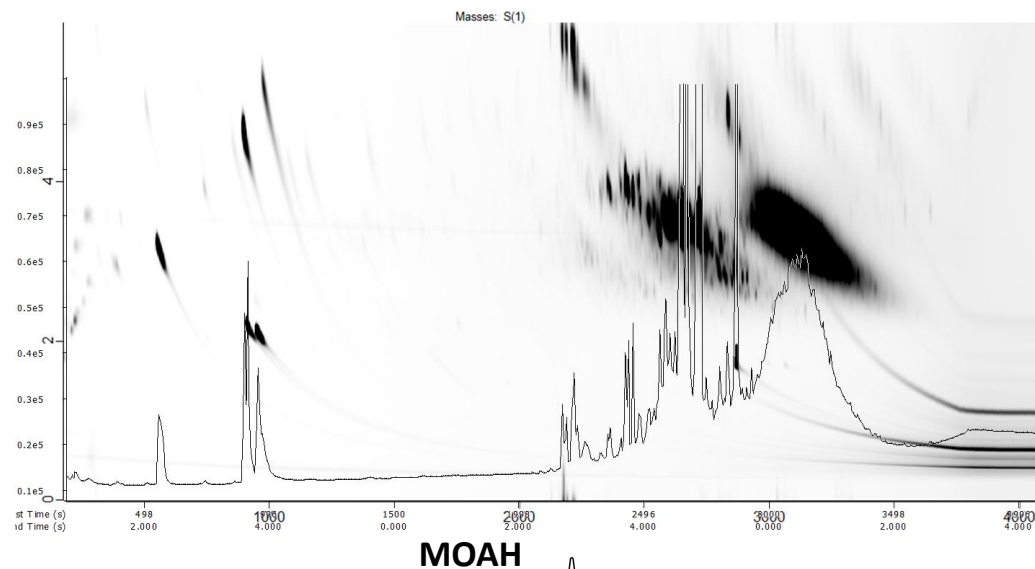
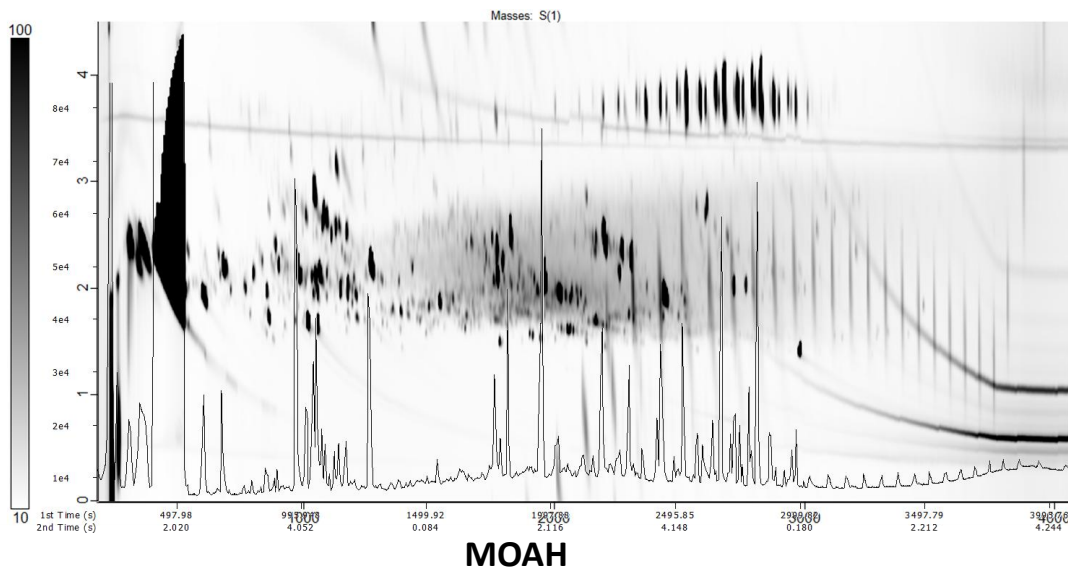
LC-GC-FID



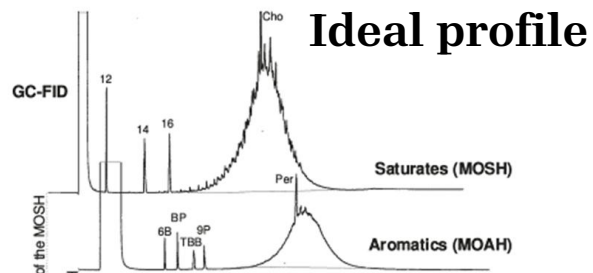
How to support the interpretation?

GC×GC

Easier interpretation

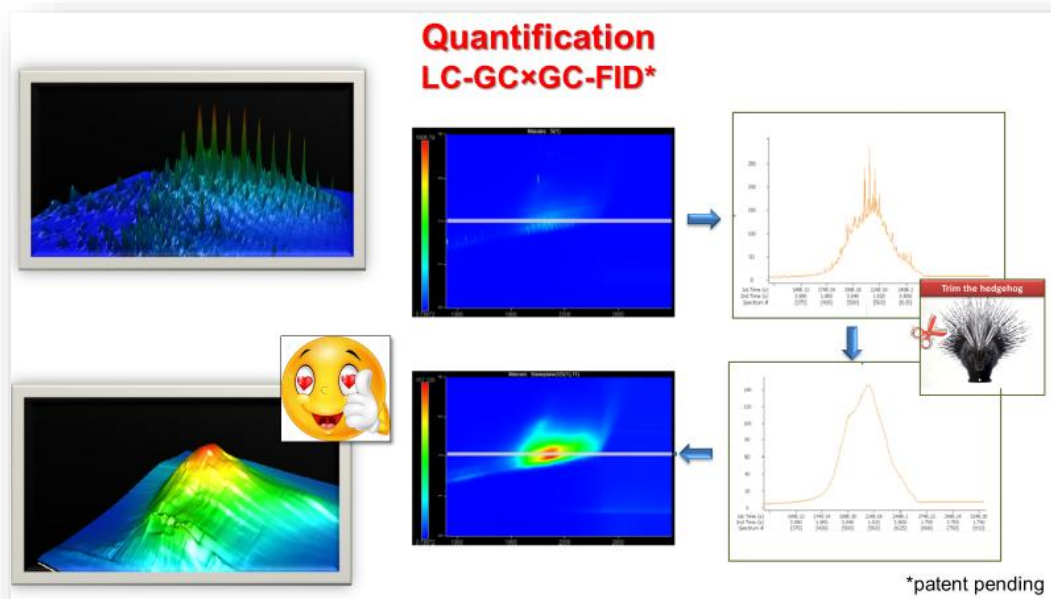


MOSH & MOAH: Analytical Determination



How to support the interpretation?

GC×GC



**MOSH & MOAH
& sub-classes
quantification in 2D**



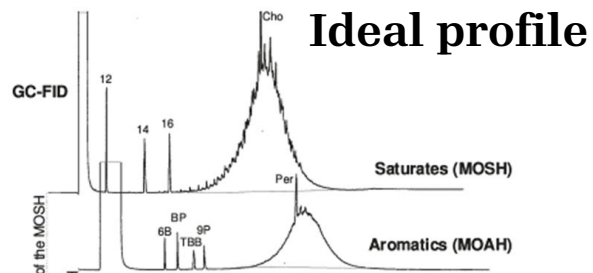
MOSH & MOAH: Analytical Determination



EXTRACTION/SAPONIFICATION

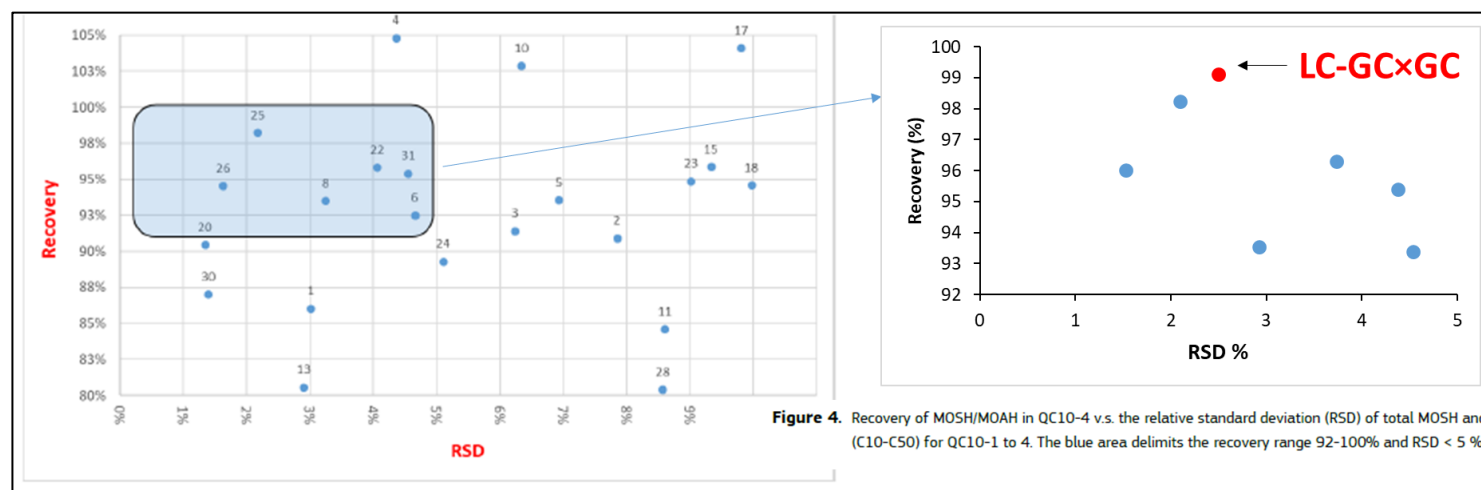
PURIFICATION

LC-GC-FID

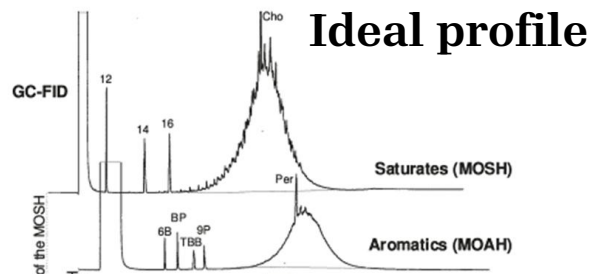


How to support the interpretation?

GC×GC

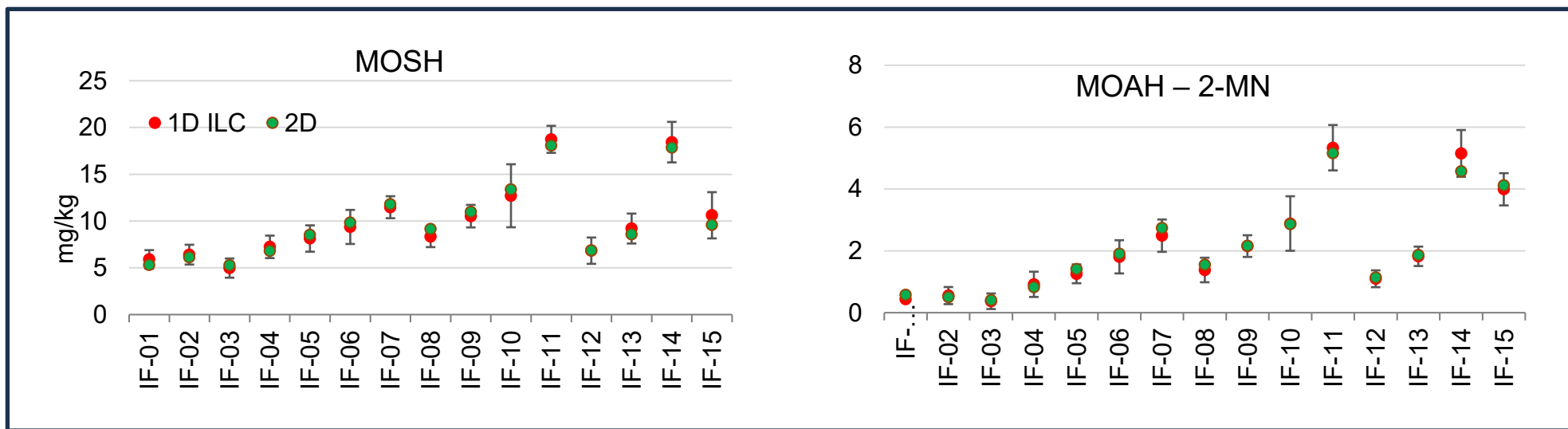


MOSH & MOAH: Analytical Determination

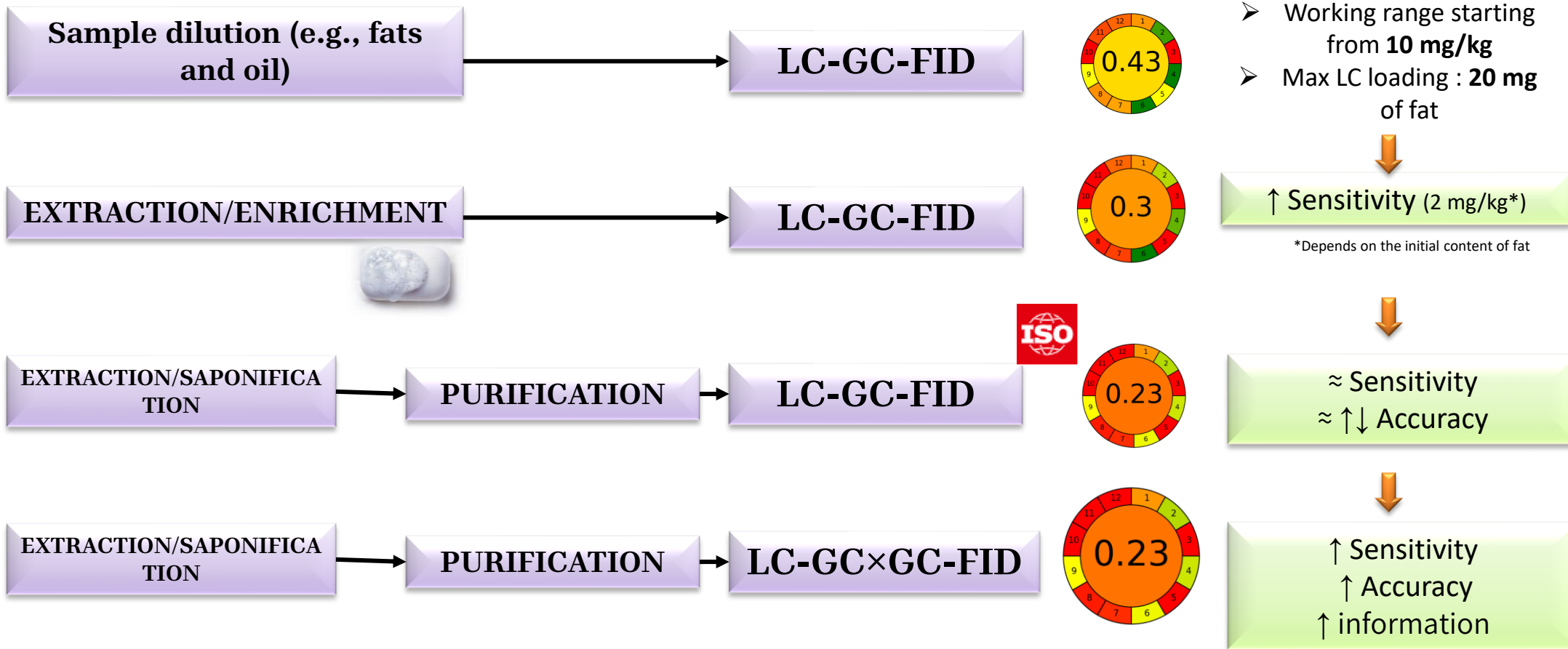


How to support the interpretation?

GC×GC



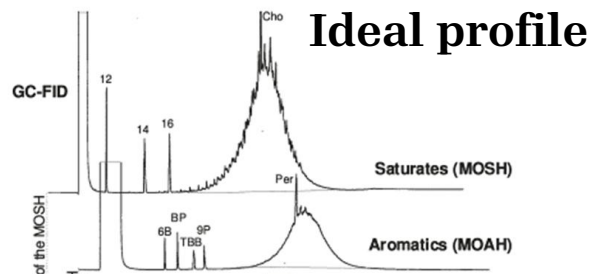
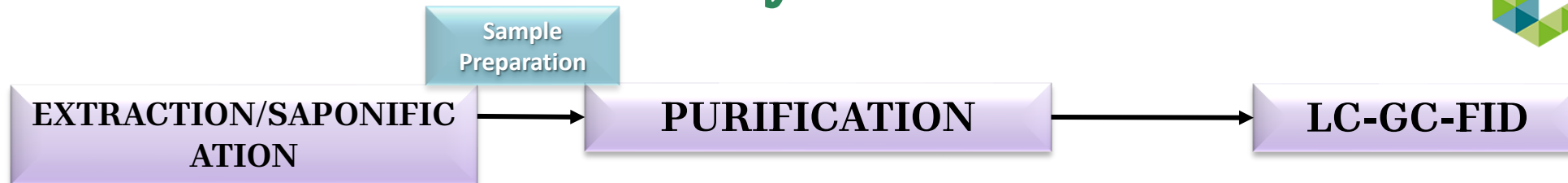
MOSH & MOAH: Analytical Determination



*Depends on the initial content of fat

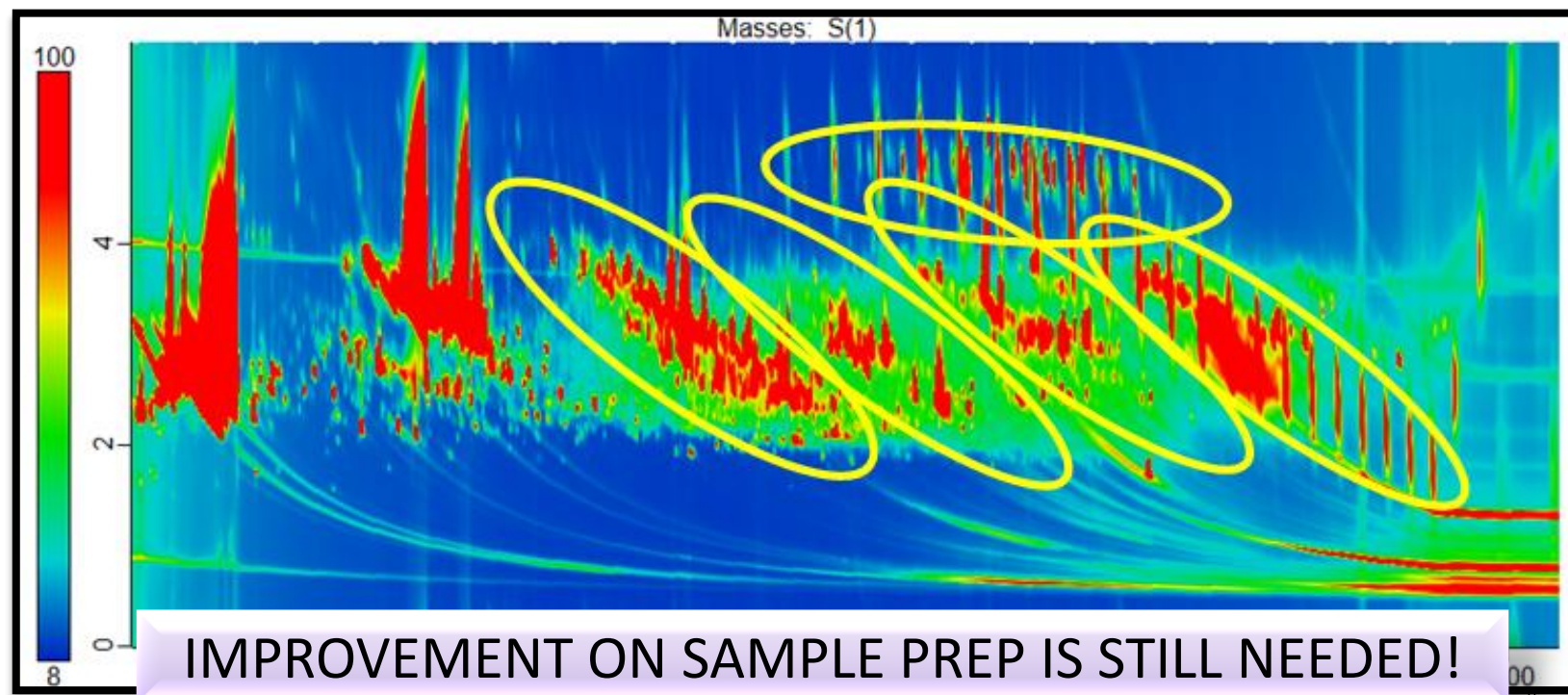


MOSH & MOAH: Analytical Determination



How to support the interpretation?

GC×GC



MOSH & MOAH: Analytical Determination



EXTRACTION/SAPONIFICATION

PURIFICATION

LC-GC-FID

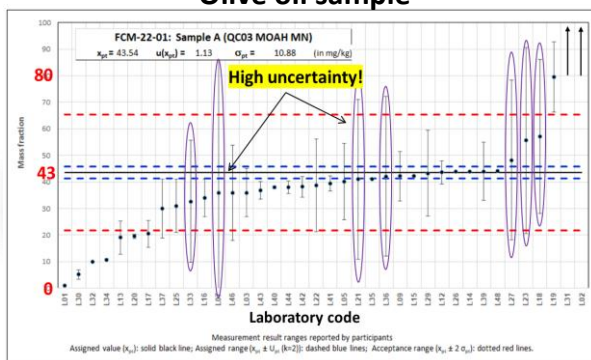


JRC Edible oil PT



ISO 20122:2024

Olive oil sample



In order to ensure correct signal evaluation, especially at the level of the LOQ, the offset of the baseline in the area of integration of MOSH and MOAH must not exceed one quarter of the height of the signal to be integrated (see Figure 18, Annex A). In such cases the chromatographic separation performance of the system must be improved or the LOQ must be increased.

In summary, the following conditions should be examined:

- appropriate straight baseline, blank level $\leq 1/3$ of the LOQ.
- peaks are symmetrical and do not show a significant tailing.
- complete separation of solvent and C10.
- discrimination C10/C20 and C50/C20 between $80\% \leq x \leq 120\%$.
- peak ratio between TBB and 2MN ≤ 1.25 .

- Check the LOQ or a matrix by adding a suitable mineral oil product before sample preparation. The signal of the hump at the LOQ should have a relative standard deviation $\leq 20\%$ and a signal to noise ratio ≥ 10 . In addition, the LOQ should be tested with a mineral oil product, whose signal width from start to end is comparable to or higher than the boiling range of the MOH in the sample to be evaluated.

Not specifically discussed, but discrepancies TBB/2MN observed from multiple labs

peak ratio between TBB and 2MN ≤ 1.25

peak ratio between TBB and 2MN = 1.00

Infant Formula



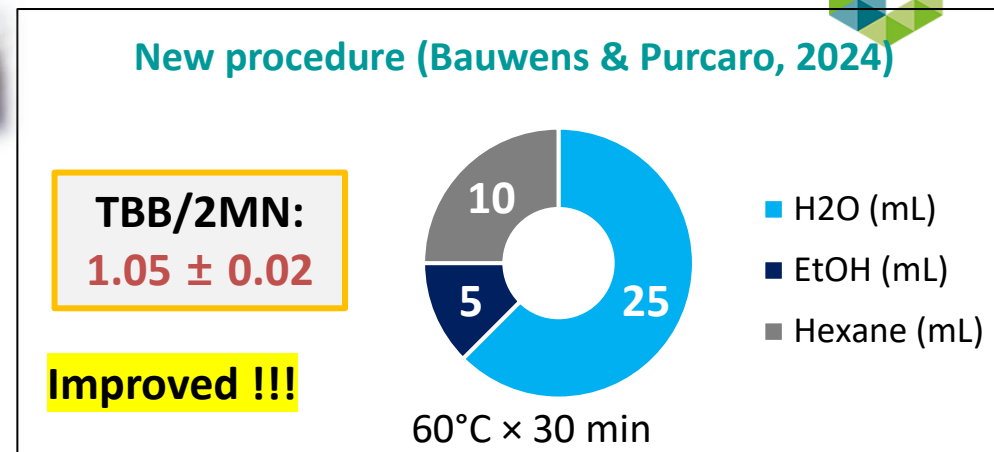
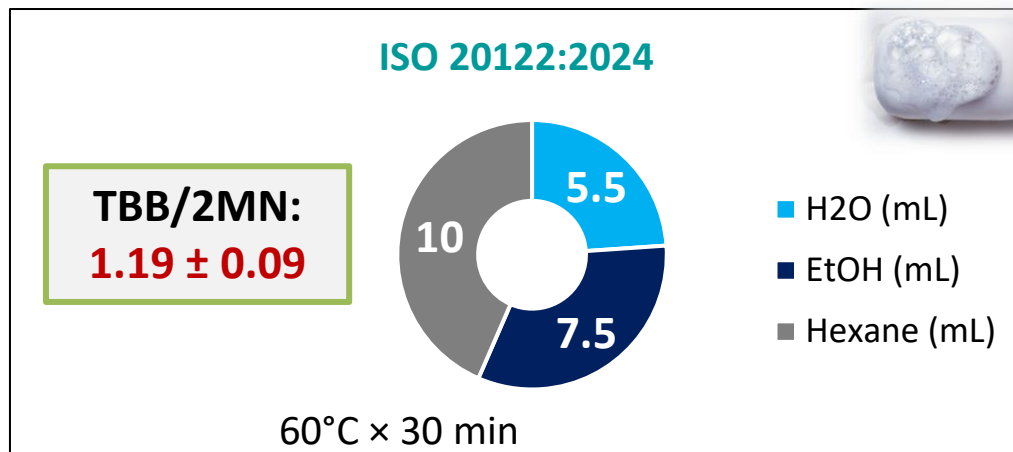
Even if statistically negligible, the mass fraction of total MOAH referred to TBB was constantly 13 % lower than the one obtained using 2MN. It is therefore recommended, in order to ensure proper comparability of results, to report the MOAH in IF using TBB as the internal standard.

Still, users should be aware that this experimental protocol does not fully remove all the interfering compounds present in some challenging matrices, which may require a cautious interpretation and integration of the recorded chromatograms. Further characterisation with two-dimensional GC-GC techniques may be required.

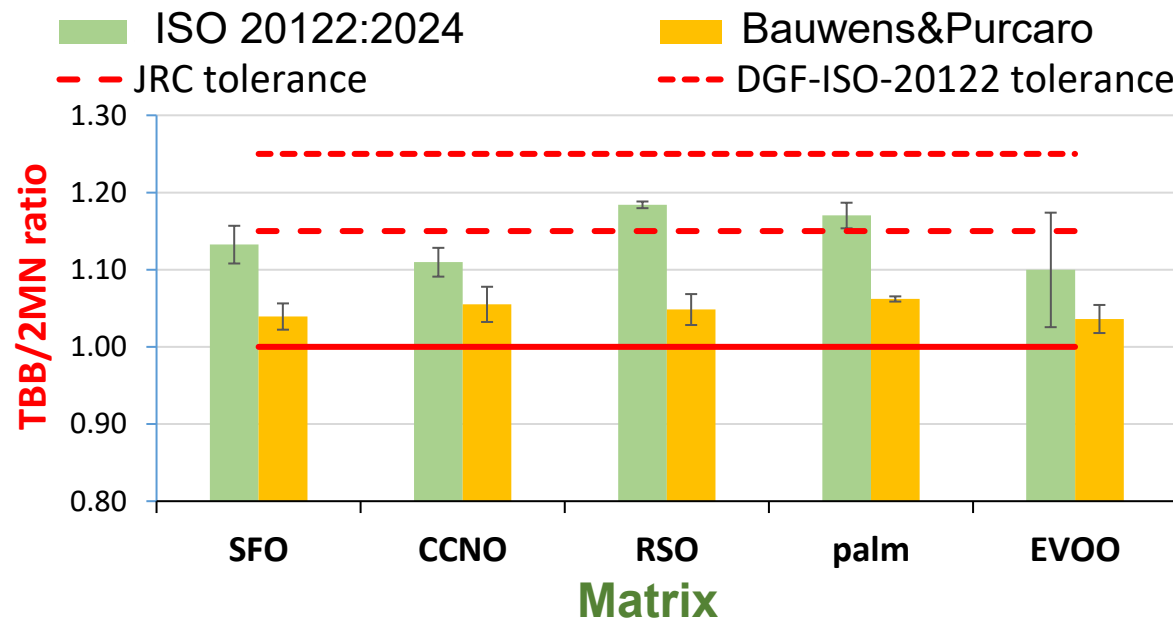
total MOAH referred to **TBB** was constantly **13 %** lower than the one obtained using **2MN**.

Sample Preparation

MOSH & MOAH: New Advancements

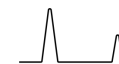


Reduction of the « polarity-based discrimination »
No matter the selected standard, the MOAH concentration would be the same

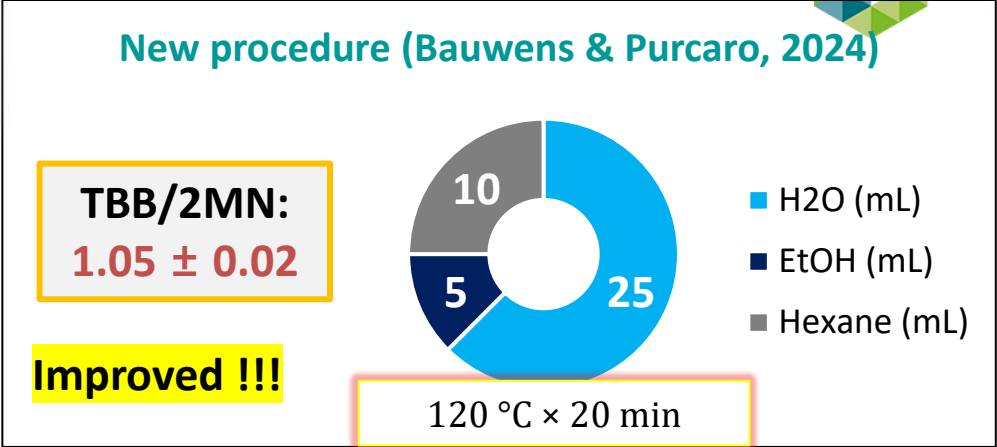
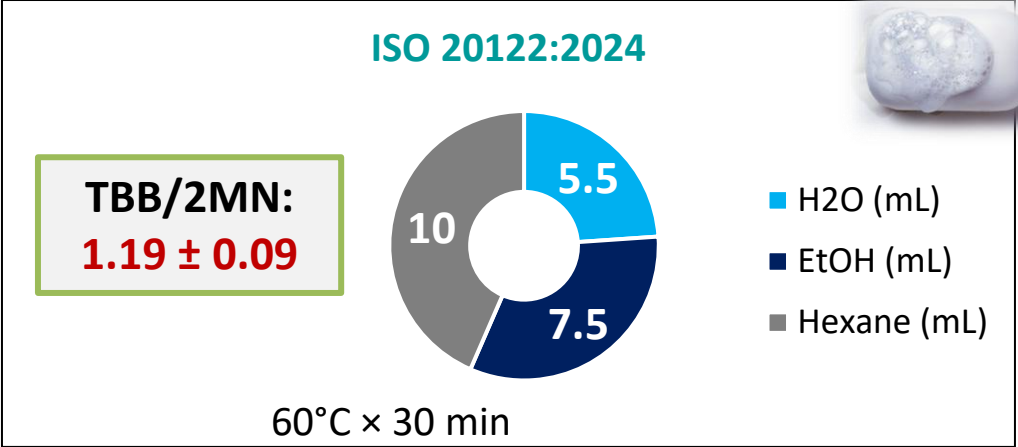


TBB/MN= 1.05±0.02

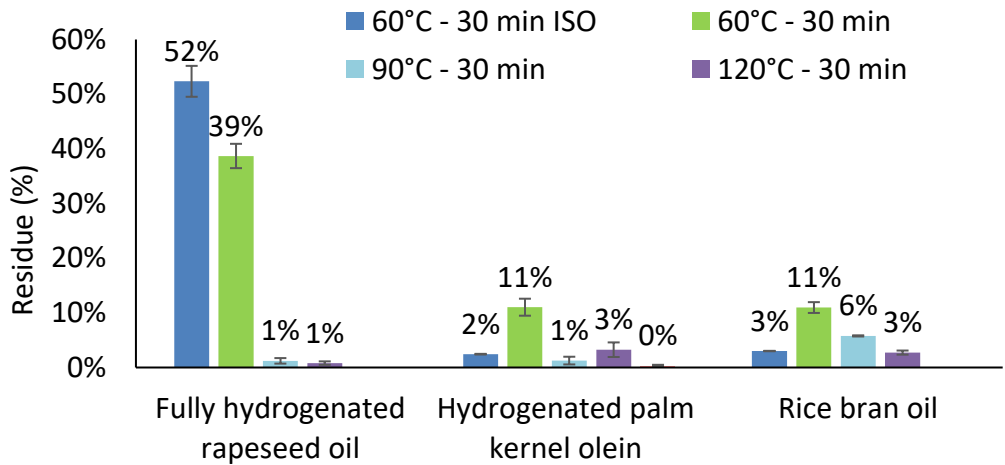
Sample Preparation



MOSH & MOAH: New Advancements



Reduction of the « polarity-based discrimination »
No matter the selected standard, the MOAH concentration would be the same

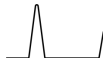


	MASE TBB/2MN
Crude palm oil	0.97 ± 0.01
No matrix	1.02 ± 0.02
FH Palm Oil	1.02 ± 0.05
FH Coconut Oil	1.04 ± 0.02
Rice Bran Oil	1.05 ± 0.05
Rapeseed Oil	1.06 ± 0.01
FH Palm Kernel Olein	1.07 ± 0.02
Coconut Oil	1.07 ± 0.01
Fish Oil	1.07 ± 0.02
Refined Palm Oil	1.07 ± 0.05
Extra virgin olive oil	1.13 ± 0.01
FH Rapeseed oil	1.16 ± 0.00

TBB/MN= 1.05±0.01

The method however showed to not be efficient on some high-melting matrices. So, time and temperature were re-optimized

Sample Preparation



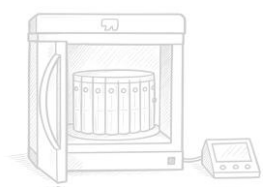
MOSH & MOAH: Analytical Determination

2ND GREEN ANALYTICAL CHEMISTRY WORKSHOP
2/3
FEBRUARY, 2026
NOVOTEL PARIS CHARENTON

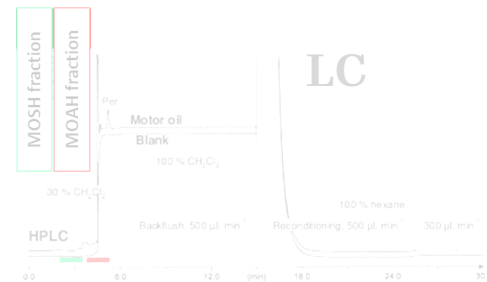
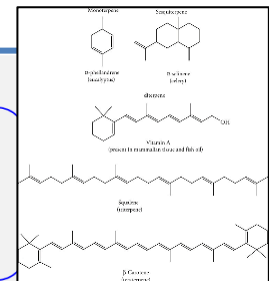
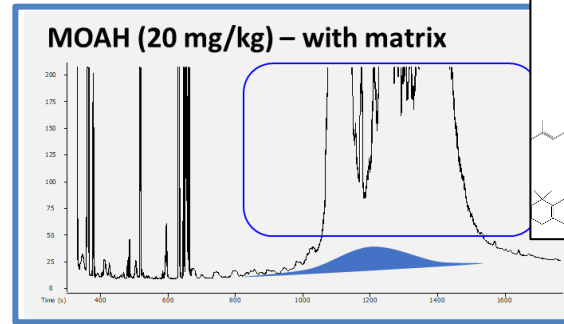
EXTRACTION/SAPONIFICATION

PURIFICATION

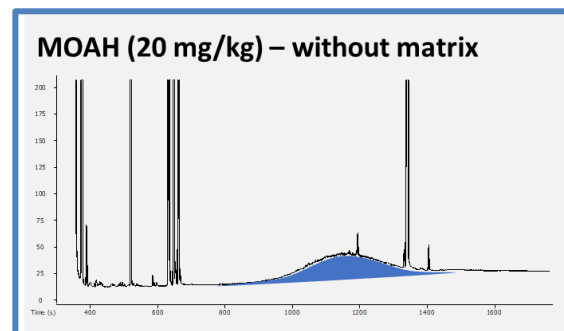
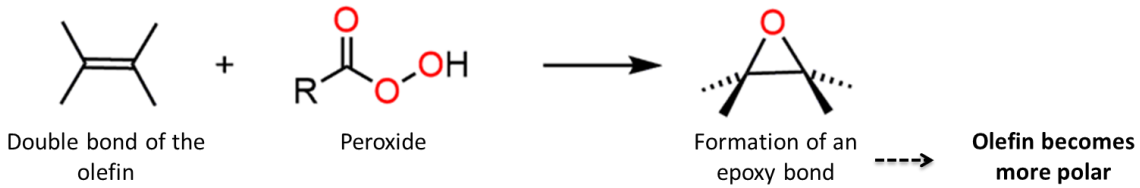
LC-GC-FID



Microwave-assisted saponification and extraction (MASE) method



EPOXIDATION



Loss of 20-40% of MOAH

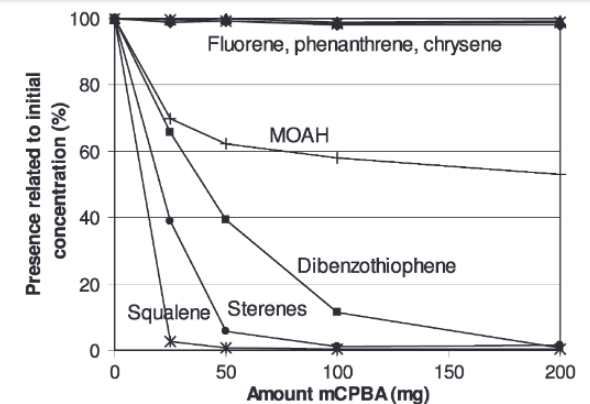


Figure 3. Epoxidation with different amounts of peracid. More peracid better removes squalene and the sterenes, but also the loss of certain aromatics increases.

Sample Preparation

Works rather well but also **attacks** MOAH due to their double bonds

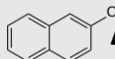
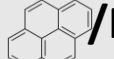
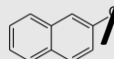
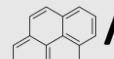
ROUTINE PURIFICATION METHOD



- Purification

Epoxidation performed manually

MOAH RECOVERY (%)

	PALM OIL		SUNFLOWER OIL	
	 /2MN	 /PYR	 /2MN	 /PYR
MCPBA ($n_{PO}=2$, $n_{SFO}=1$)	*65% ($\pm 21\%$)	*38% ($\pm 7\%$)	98%	56%
PER AC C6 ($n=3$)	177% ($\pm 36\%$)	105% ($\pm 36\%$)	146 ($\pm 12\%$)	124 ($\pm 58\%$)
PER AC CHCl₃ ($n=3$)	79% ($\pm 29\%$)	61% ($\pm 29\%$)	61% ($\pm 19\%$)	47% ($\pm 19\%$)

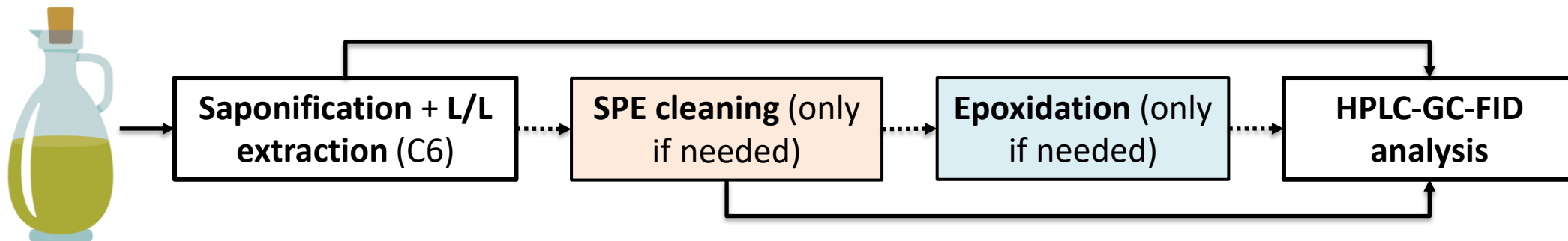
Oils spiked with **15 mg/kg** (*7.5 mg/kg) of a mixture of of **Gravex** (very volatile MOAH), **SN100 Aromatic Extract** (mid volatility), **SN500 Aromatic Extract** (heavy fraction)

Low and Variable Recoveries!!!

Sample Preparation

MOSH & MOAH: New Advancements

ISO 20122:2024 **Vegetable oils** — Determination of mineral oil saturated hydrocarbons (MOSH) and aromatic hydrocarbons (MOAH) with online coupled HPLC-GC-FID analysis — Method for low limit of quantification



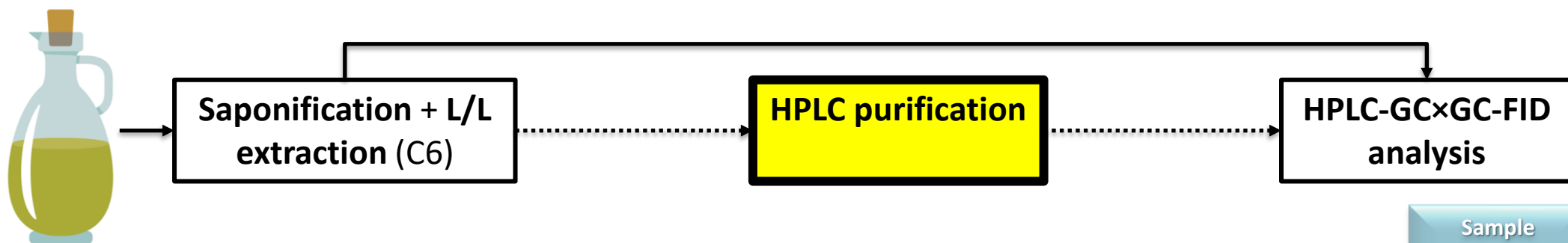
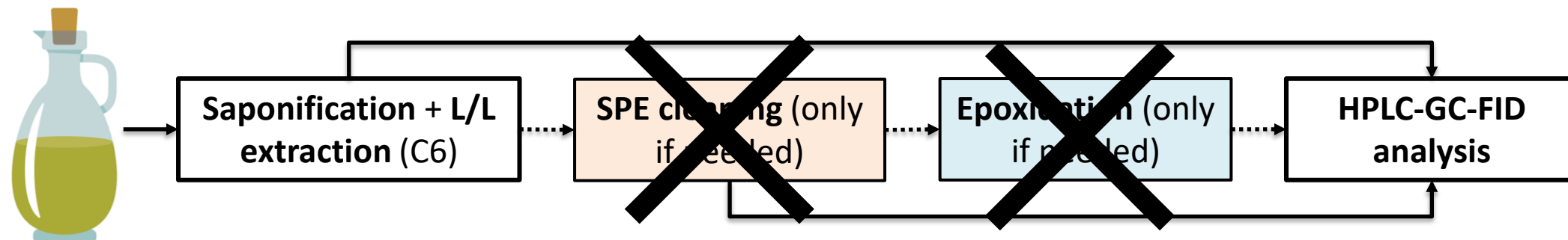
The issue with the current purification method for MOAH (i.e., epoxidation) is that it relies on a **non-selective chemical reaction which also attacks MOAH**.

It would therefore be relevant to develop a purification method which is not based on a chemical reaction anymore.

Sample Preparation

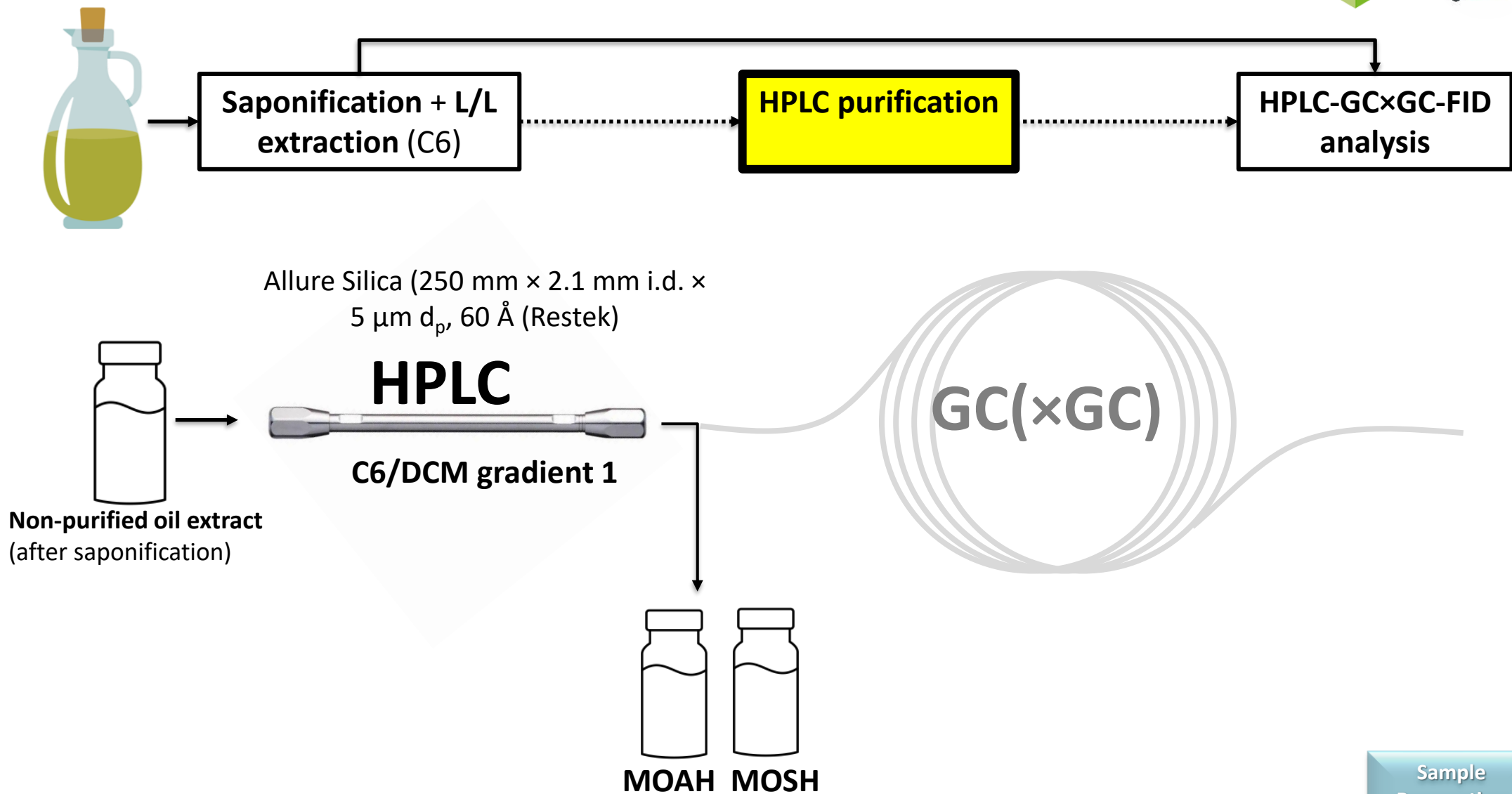


ISO 20122:2024 **Vegetable oils** — Determination of mineral oil saturated hydrocarbons (MOSH) and aromatic hydrocarbons (MOAH) with online coupled HPLC-GC-FID analysis — Method for low limit of quantification



Sample Preparation

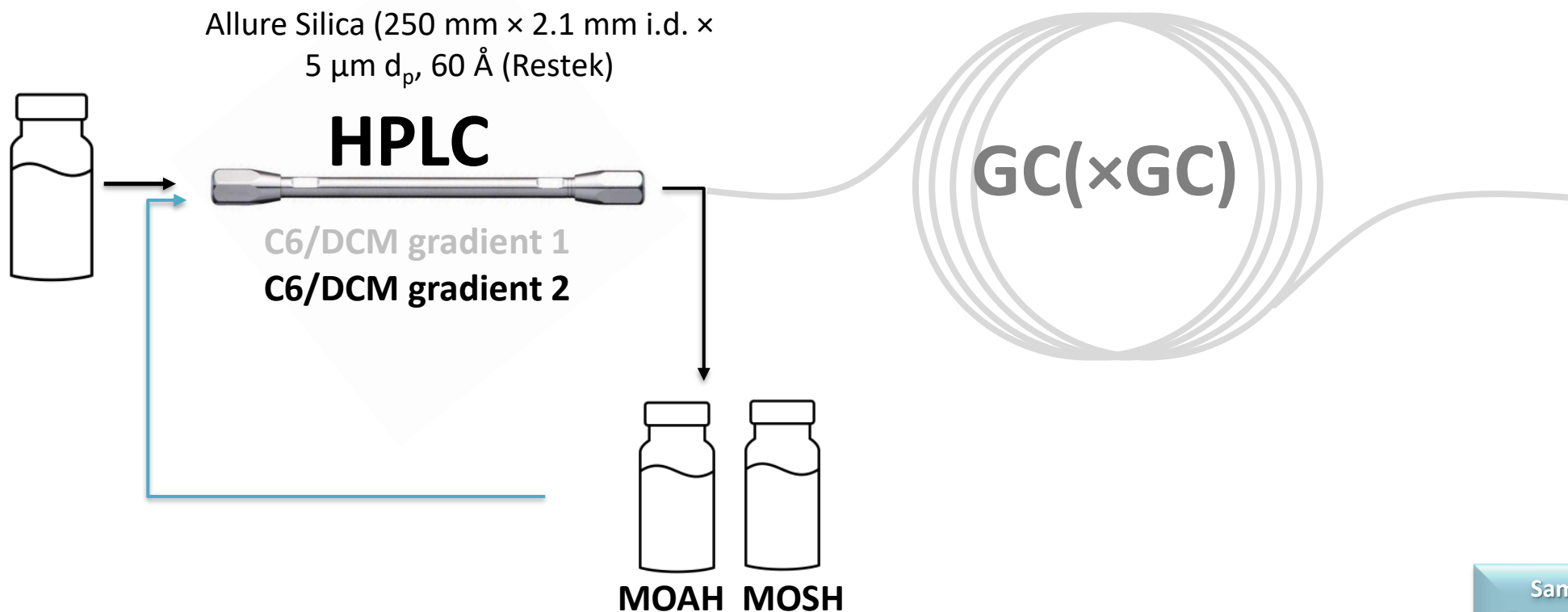
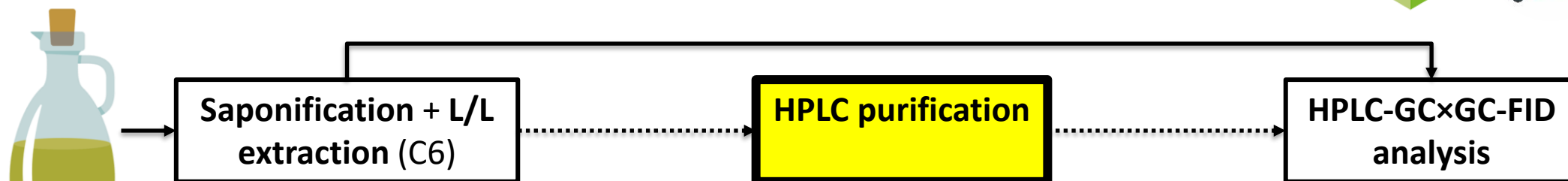
MOSH & MOAH: New Advancements



Gradient 1: 0 min 100% C6; 1.5–6 min 65% C6 35% DCM at 0.3 mL/min

Sample Preparation

MOSH & MOAH: New Advancements



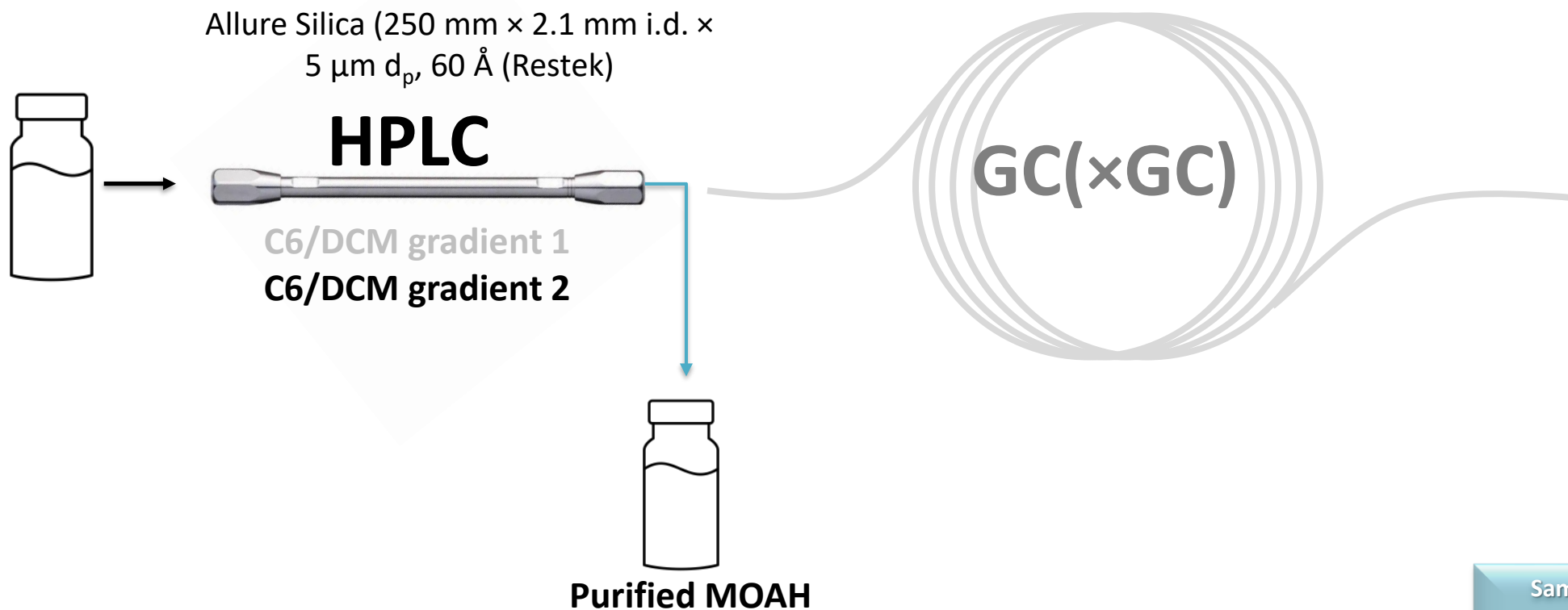
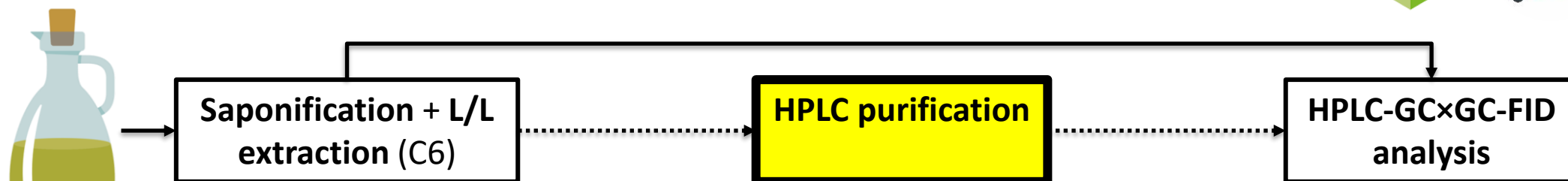
Sample Preparation

Gradient 1: 0 min 100% C6; 1.5–6 min 65% C6 35% DCM at 0.3 mL/min

Gradient 2: 0 min 100% C6; 1.5–14.5 min 98% C6 2% DCM; 14.5–23 min 95% C6 5% DCM at 0.3 mL/min



MOSH & MOAH: New Advancements



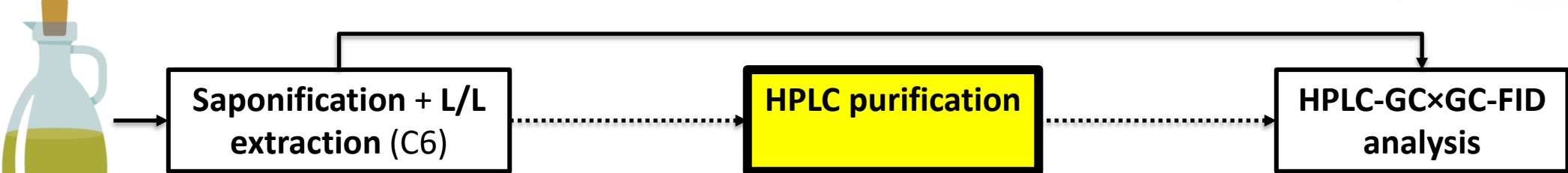
Sample Preparation

Gradient 1: 0 min 100% C6; 1.5–6 min 65% C6 35% DCM at 0.3 mL/min

Gradient 2: 0 min 100% C6; 1.5–14.5 min 98% C6 2% DCM; 14.5–23 min 95% C6 5% DCM at 0.3 mL/min

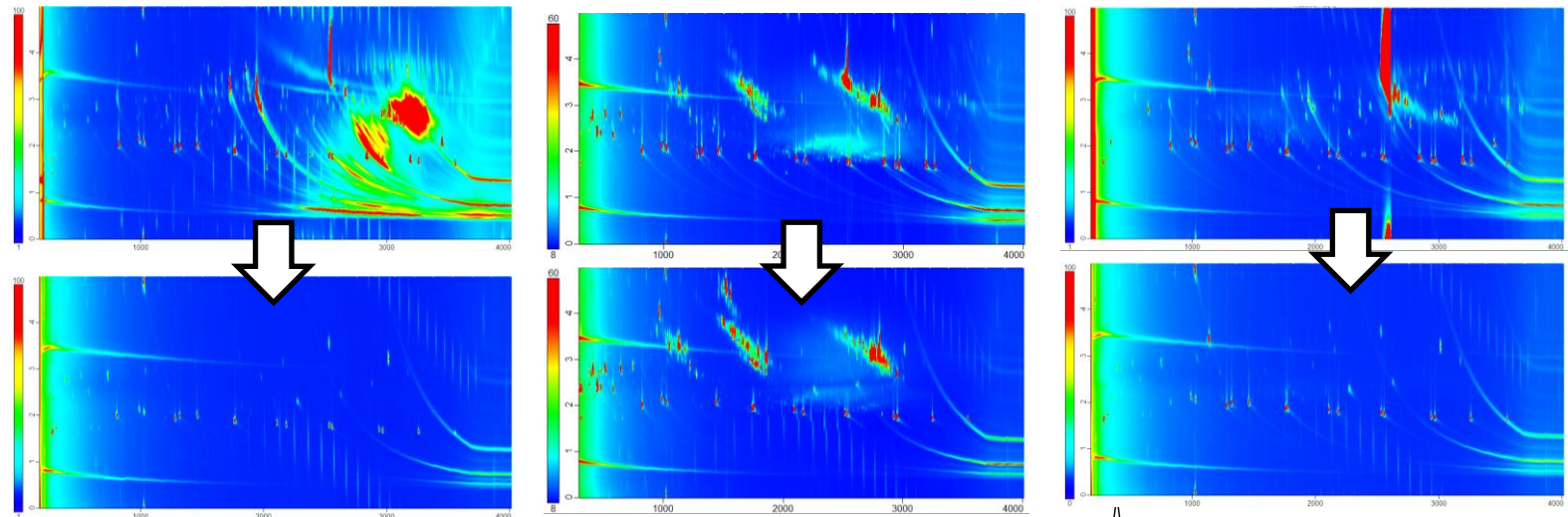


MOSH & MOAH: New Advancements



Very good removal of carotenoids and squalene

Other terpenoids are less well removed



MOSH & MOAH: New Advancements



Saponification + L/L extraction (C6)

HPLC purification

HPLC-GC×GC-FID analysis

Very good removal of carotenoids and squalene

Other terpenoids are less well removed



Epoxidation

mCPBA

82% ± 10%

performic acid

71 ± 16%

MOAH Recovery LC Purification:

94% ± 2%



MOAH recovery (%)

92%

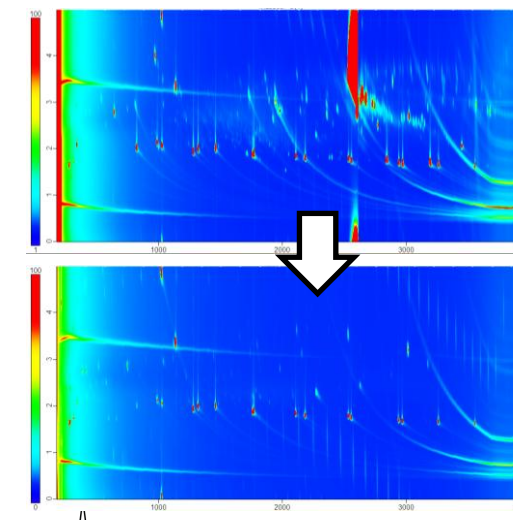
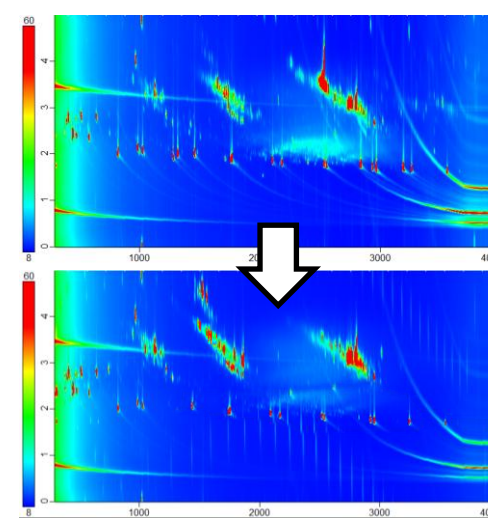
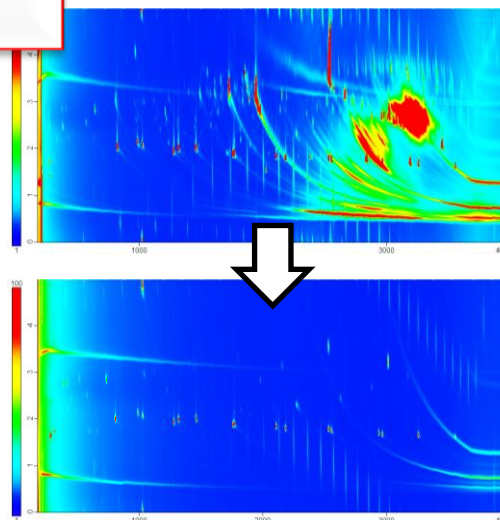
93%

98%

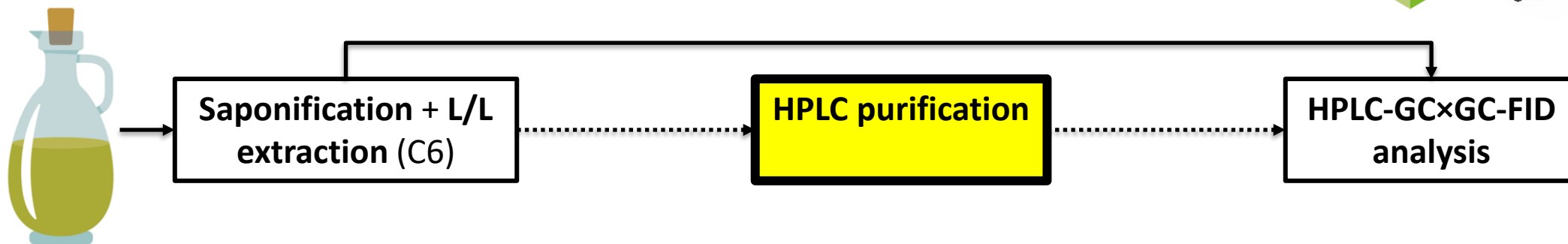
PALM OIL
(n=2)

SUNFLOWER OIL
(n=2)

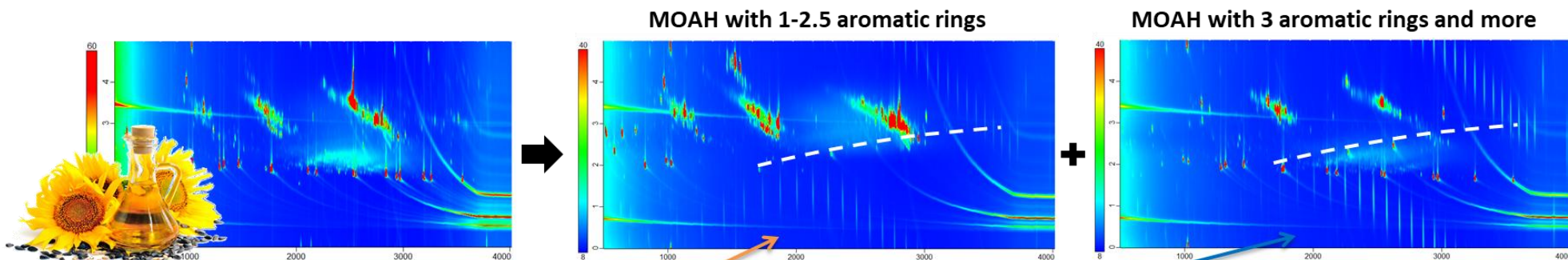
OLIVE OIL
(n=2)



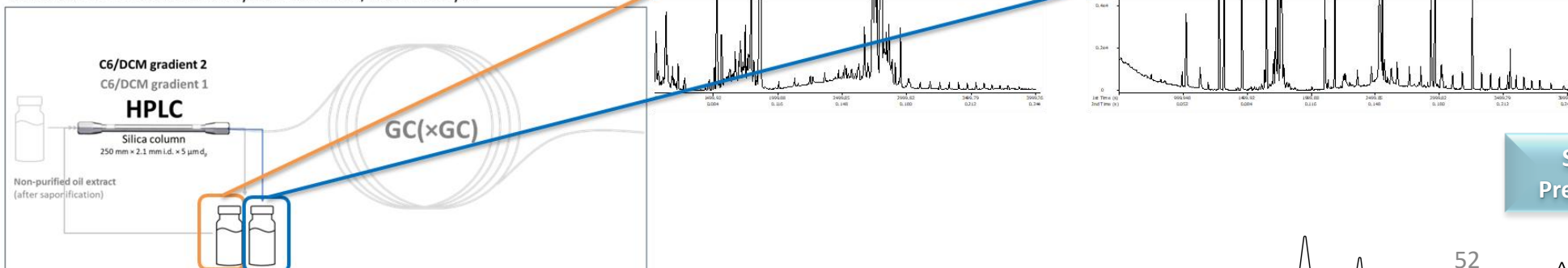
MOSH & MOAH: New Advancements



The LC purification method also allows to **separate** and **quantify** MOAH based on their **number of aromatic rings**.



HPLC-GC-FID = most common system for MOSH/MOAH analysis



Sample Preparation

GREEN CHEMISTRY

GREEN ANALYTICAL CHEMISTRY

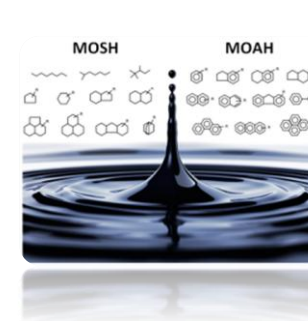
- S Select direct analytical technique
- I Integrate analytical processes and operations
- G Generate as little waste as possible
- N Never waste energy
- I Implement automation and miniaturization
- F Favor reagents from renewable sources
- I Increase safety for the operator
- C Carry out in-situ measurements
- A Avoid derivation
- N Note minimal sample number and size
- C Choose multi-analyte or multi-parameter methods
- E Eliminate or replace toxic reagents

→ LC-GC-FID, no MS

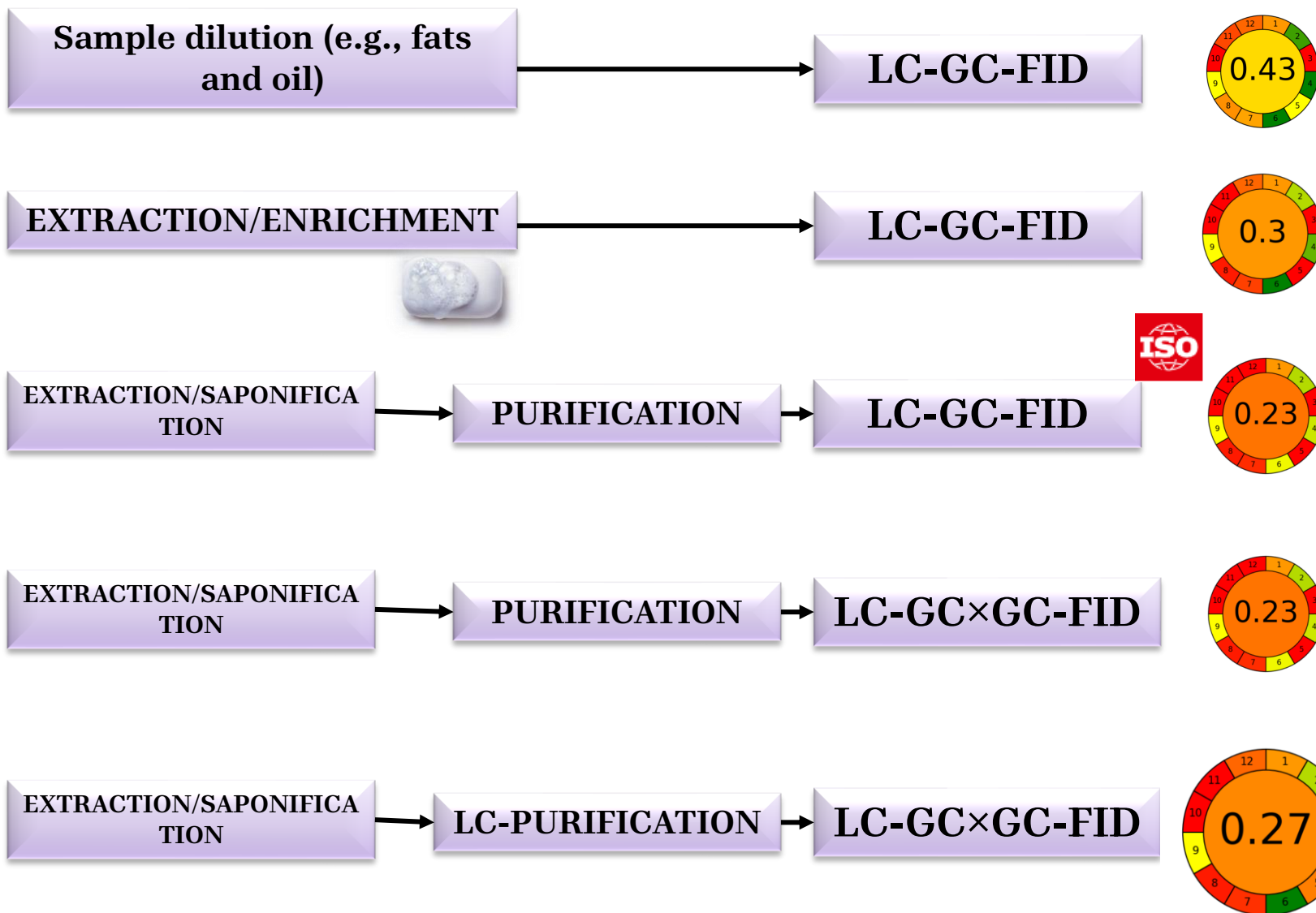
→ Partially Automated

→ Online method

→ UCM



MOSH & MOAH: Analytical Determination



- Working range starting from **10 mg/kg**
- Max LC loading : **20 mg** of fat

↑ Sensitivity (2 mg/kg*)

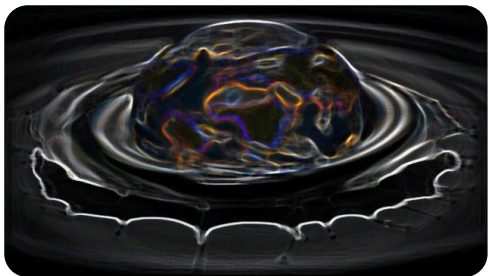
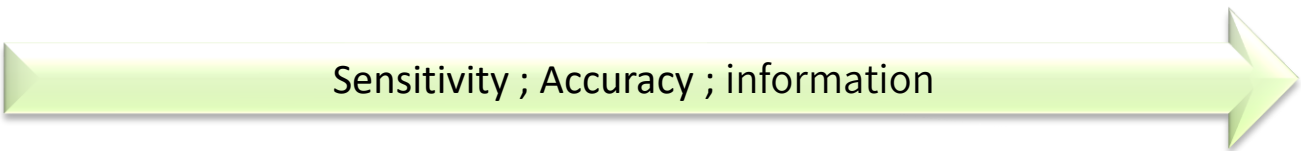
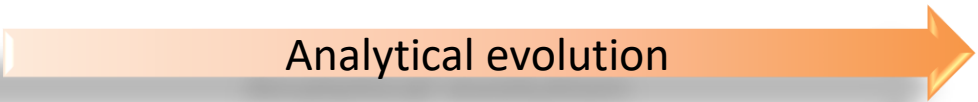
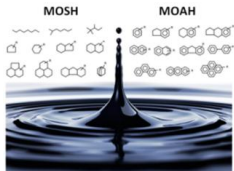
*Depends on the initial content of fat

≈ Sensitivity
≈ ↑↓ Accuracy

↑ Sensitivity
↑ Accuracy
↑ information

↑ Sensitivity
↑↑ Accuracy
↑ information

MOSH & MOAH: How green are we?

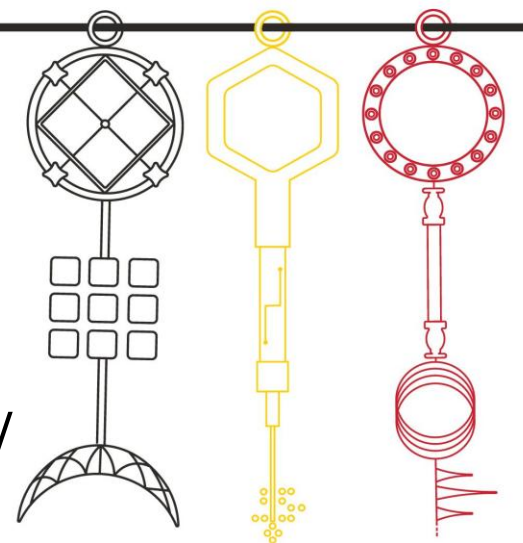


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ExTech 2026

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BECAUSE SCIENCE IS THE KEY

Thank you for the attention

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