

L'ORÉAL

RECHERCHE
& INNOVATION



Authentication of natural ingredients from cosmetic industry

The Green Analytical Chemistry Workshop

03/02/2026

Aurélien CUCHET



THE
GREEN
ANALYTICAL
CHEMISTRY
WORKSHOP

2ND GREEN ANALYTICAL CHEMISTRY WORKSHOP

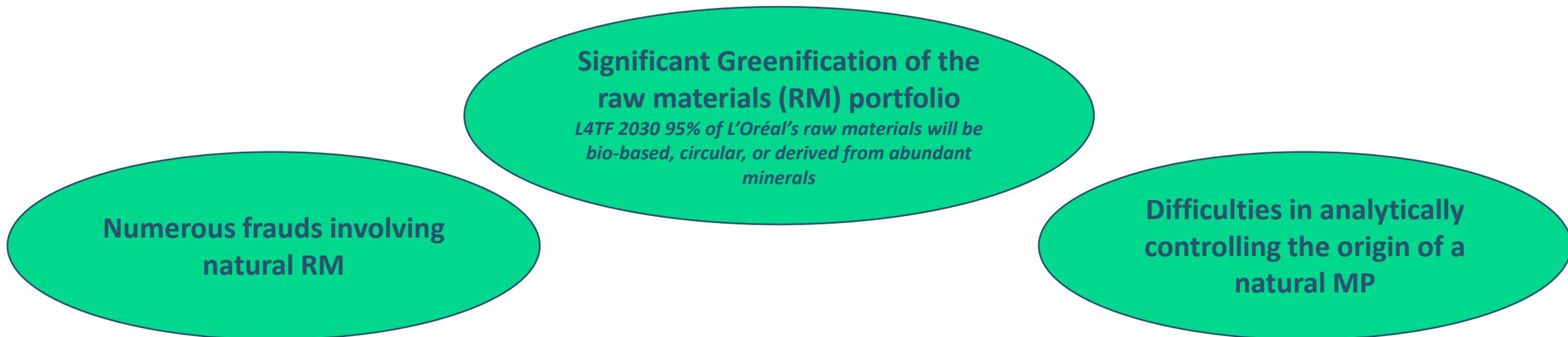
FEBRUARY 2/3, 2026 - NOVOTEL PARIS CHARENTON

www.tgacworkshop-paris.com



CONTEXT

GREENIFICATION OF PORTFOLIO



Main risks

Regulatory	Reputational	Financial
<ul style="list-style-type: none">• Natural claim (cf ISO 16128)• Animal origin	<ul style="list-style-type: none">• Greenwashing• False advertisement	<ul style="list-style-type: none">• Purchases / Inconsistent pricing of natural RM vs. quality

We need to improve the authentication of natural RM to ensure their origins!

CONTEXTE

NATURALNESS CLAIM



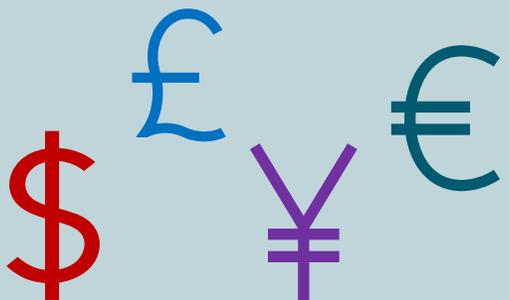
Claim « % of natural in a formula »



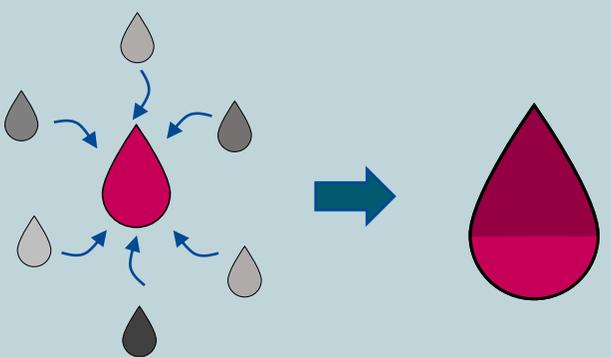
Claim of a "natural ingredient or active ingredient" in a formula

CONTEXT

NUMEROUS FRAUDS



Heavy prices



Rise the production volumes

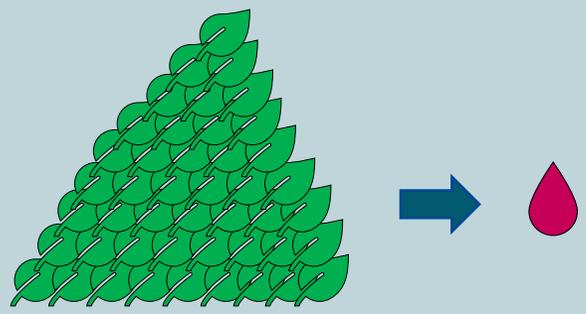
Natural raw materials
are subject to many
frauds



ISO/TC 54
ISO 3218:2014
ISO 9235:2021

cen afnor

Conformity to specifications



Low yield of production

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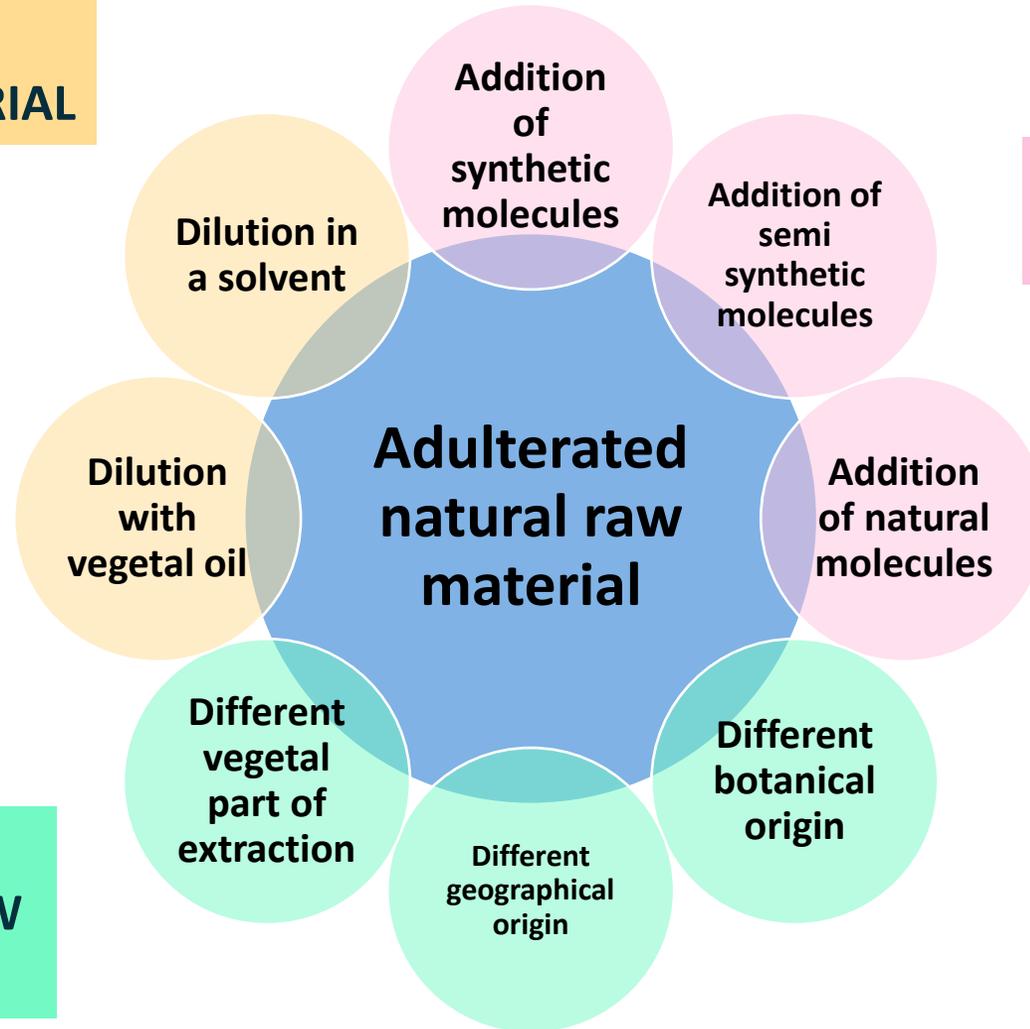
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CONTEXT

NUMEROUS FRAUDS

**DILUTION OF THE
NATURAL RAW MATERIAL**

**ADDITION OF
MOLECULES**



**MIXTURE WITH ANOTHER
FLAVOR OR FRAGRANCE RAW
MATERIAL**

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ANALYTICAL STRATEGIES OF AUTHENTICATION

AN ANALYTICAL CHALLENGE

ADULTERATIONS



COMPLEX ADULTERATIONS



CLASSICAL
TECHNIQUES



ADVANCED TECHNIQUES
MULTIANALYSES

Examples :

- Analysis with GC-FID or GC-MS
- Olfactive Controls
- Physicochemical tests

Exemples:

- Highlights impurities
- Enantioselectives analyses
- Isotopic analyses

ANALYTICAL STRATEGIES OF AUTHENTICATION

NUMEROUS ANALYTICAL TECHNIQUES AVAILABLE

Detection of residual impurities from synthesis and natural markers

- Volatile molecules (GC-FID/MS, Comprehensive GCxGC, GC-HRMS)
- Non Volatile molecules (LC-MS/MS, Derivatization GC-MS, TGA)

Enantiomeric ratios

- Enantiomeric GC, Heart-cut MDGC

Isotopic Analyses

- Radiocarbon assessment (AMS)
- Stable isotope studies (EA-IRMS, GC-IRMS, ICP-MS, SNIF-NMR)

Other techniques

- Spectroscopic studies (NMR, FTIR, NIR)
- Chemometric & Statistical studies (PCA, PLS-DA, OPLS-DA, LDA)
- Genetic analyses

ANALYTICAL STRATEGIES OF AUTHENTICATION

DETECTION OF RESIDUAL IMPURITIES AND NATURAL MARKERS

Natural RM GC profile

Adulterated RM GC profile

Control of a natural RM using
GC-FID/MS; GCxGC-TOFMS (complex matrices)
or LC-MS/MS (non volatile matrices)



Anomaly

Identification of an impurity :
Origin non conform

ANALYTICAL STRATEGIES OF AUTHENTICATION

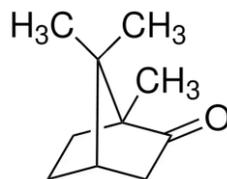
DETECTION OF RESIDUAL IMPURITIES AND NATURAL MARKERS



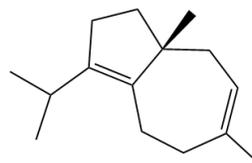
Volatile Composition (GCxGC-FID/TOFMS)

Identification of lavandin oil natural markers and abnormal high / low concentration of specific compounds

Camphor



Daucene

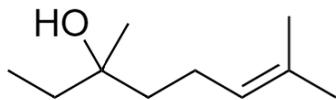


Low concentration of camphor and absence of daucene in a genuiness lavender oil

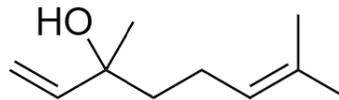
Addition of lavandin oil

Volatile Composition (GCxGC-FID/TOFMS)

Identification of linalool synthesis impurities



Dihydrolinalol



Linalol

Dihydrolinalool is produced during the synthesis of linalool

Addition of petrochemical linalool

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ANALYTICAL STRATEGIES OF AUTHENTICATION

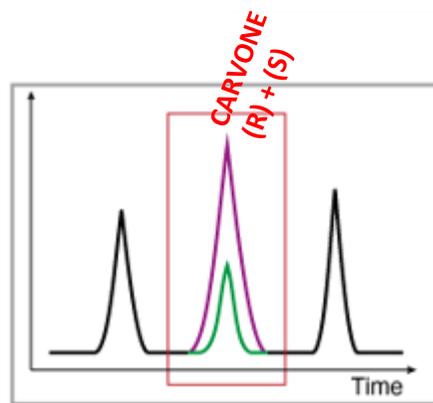
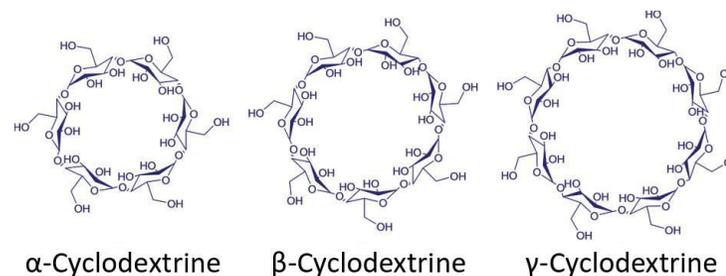
ENANTIOMERIC ANALYSES

Enzymatic catalysis induces a stereoselectivity of active secondary metabolites biosynthesis

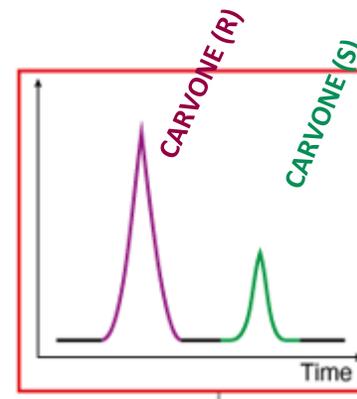
Organic synthesis leads to racemic mixtures of enantiomers

Analysis of the enantiomeric ratio can be done by chiral separations using GC analysis.

It is necessary to use columns of chiral stationary phases, consisting of cyclodextrins, to separate chiral compounds.



GC Standard analysis

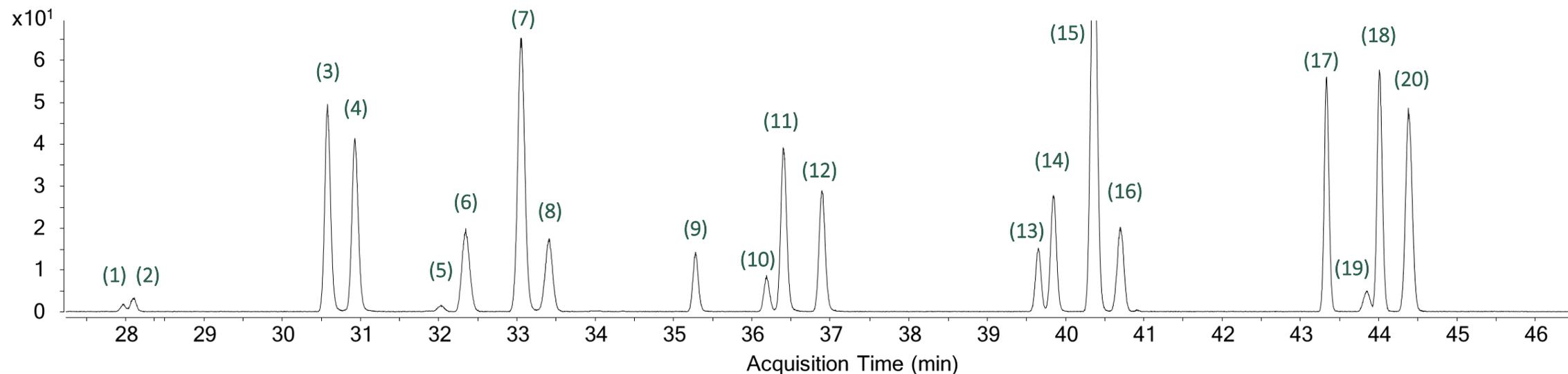


GC analysis with Cyclodextrin phase column

ANALYTICAL STRATEGIES OF AUTHENTICATION

ENANTIOMERIC ANALYSES

Complex mixtures -> Use of Multidimensional GC (Heart cutting)



Enantioselective separation of hydrocarbonated monoterpenes using MDGC (Columns HP1-Cyclosil Beta)

Alpha thujene 1(+), 2(-) ; Alpha pinene 3(-),4(+); Alpha fenchene 5(+),6(-); Camphene 7(-),8(+); Sabinene 9(+), 10(-), Beta pinene 11(+),12(-); Alpha phellandrene 13(-),14(+); Delta-3-carene 15(+),16(-), Limonene 17(-), 18(+); Beta phellandrene 19(-), 20(+)

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ANALYTICAL STRATEGIES OF AUTHENTICATION

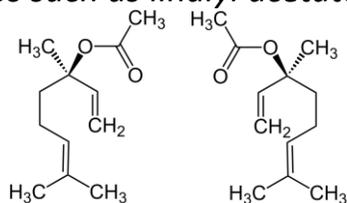
ENANTIOMERIC ANALYSES



Chiral Analysis (Enantio MDGC)

Abnormal enantiomeric ratios such as linalyl acetate

Linalyl acetate (R)



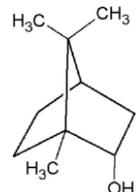
Linalyl acetate (S)

	AUTHENTIC LAVENDER (Mean Value)	PETROCHEMICAL LINALYL ACETATE	COMMERCIAL LAVENDER
(R)-Linalyl acetate	98.8%	50.0%	65%

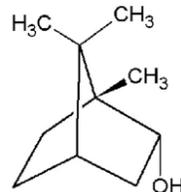
Addition of petrochemical Linalyl acetate

Chiral Analysis (Enantio MDGC)

Abnormal enantiomeric ratios such as Borneol



Borneol (+)



Borneol (-)

	AUTHENTIC LAVENDER (Mean Value)	AUTHENTIC LAVANDIN (Mean Value)	COMMERCIAL LAVENDER
(+)-Borneol	69.00%	98.10%	97.83%

Addition of lavandin oil

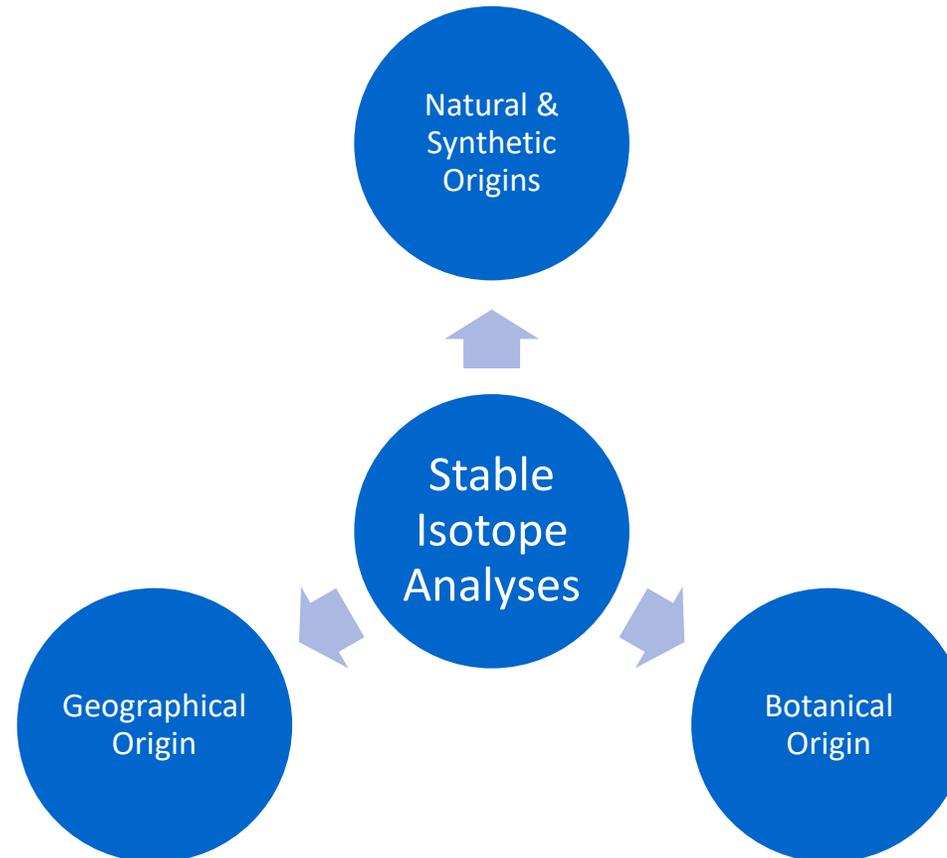
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ANALYTICAL STRATEGIES OF AUTHENTICATION

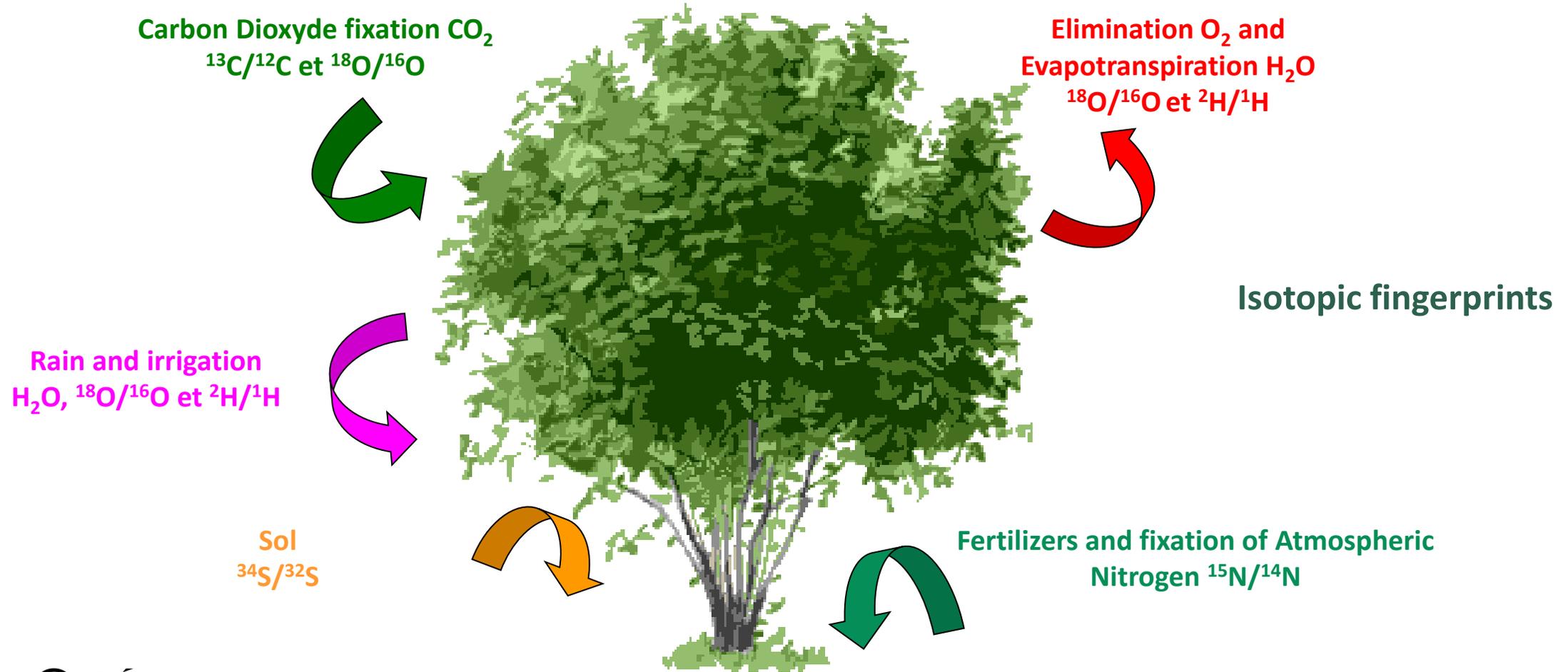
STABLE ISOTOPE ANALYSIS

- The evaluation of the stable isotope ratio leads to distinguish between synthetic and natural molecules
- Stable isotopes are used as geographical and varietal marker



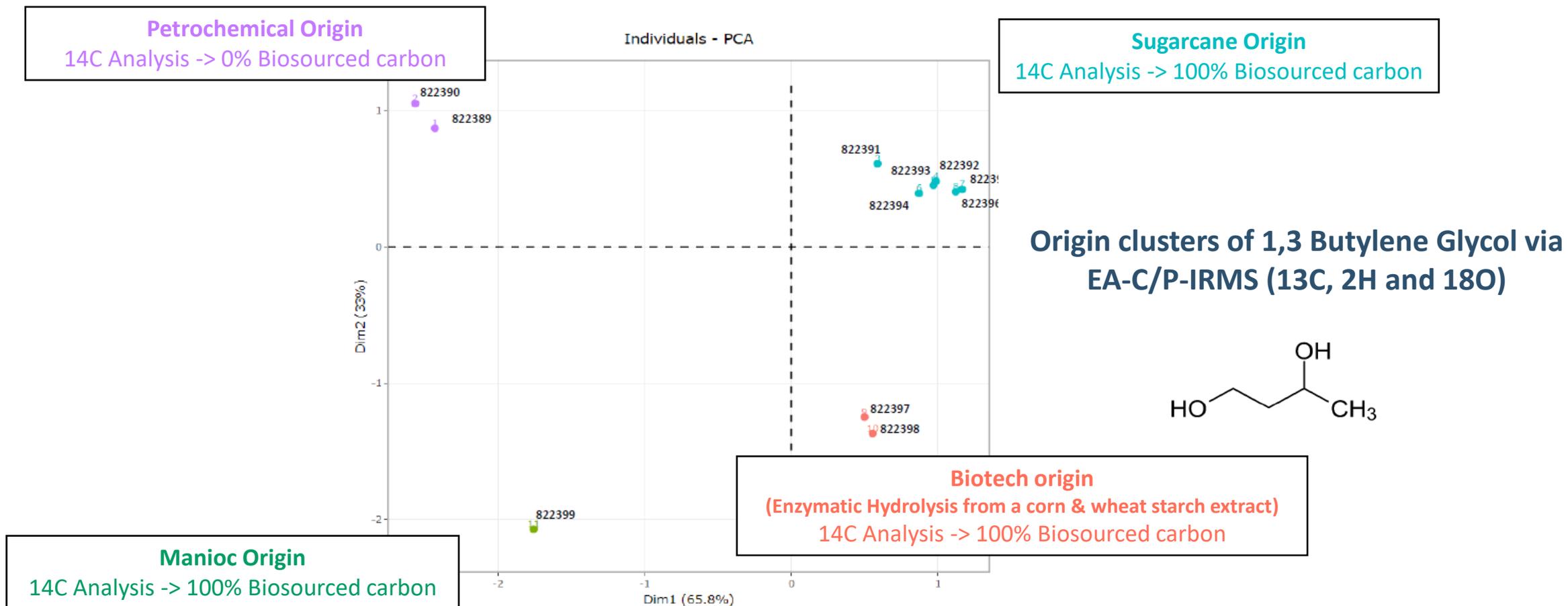
ANALYTICAL STRATEGIES OF AUTHENTICATION

STABLE ISOTOPE ANALYSIS



ANALYTICAL STRATEGIES OF AUTHENTICATION

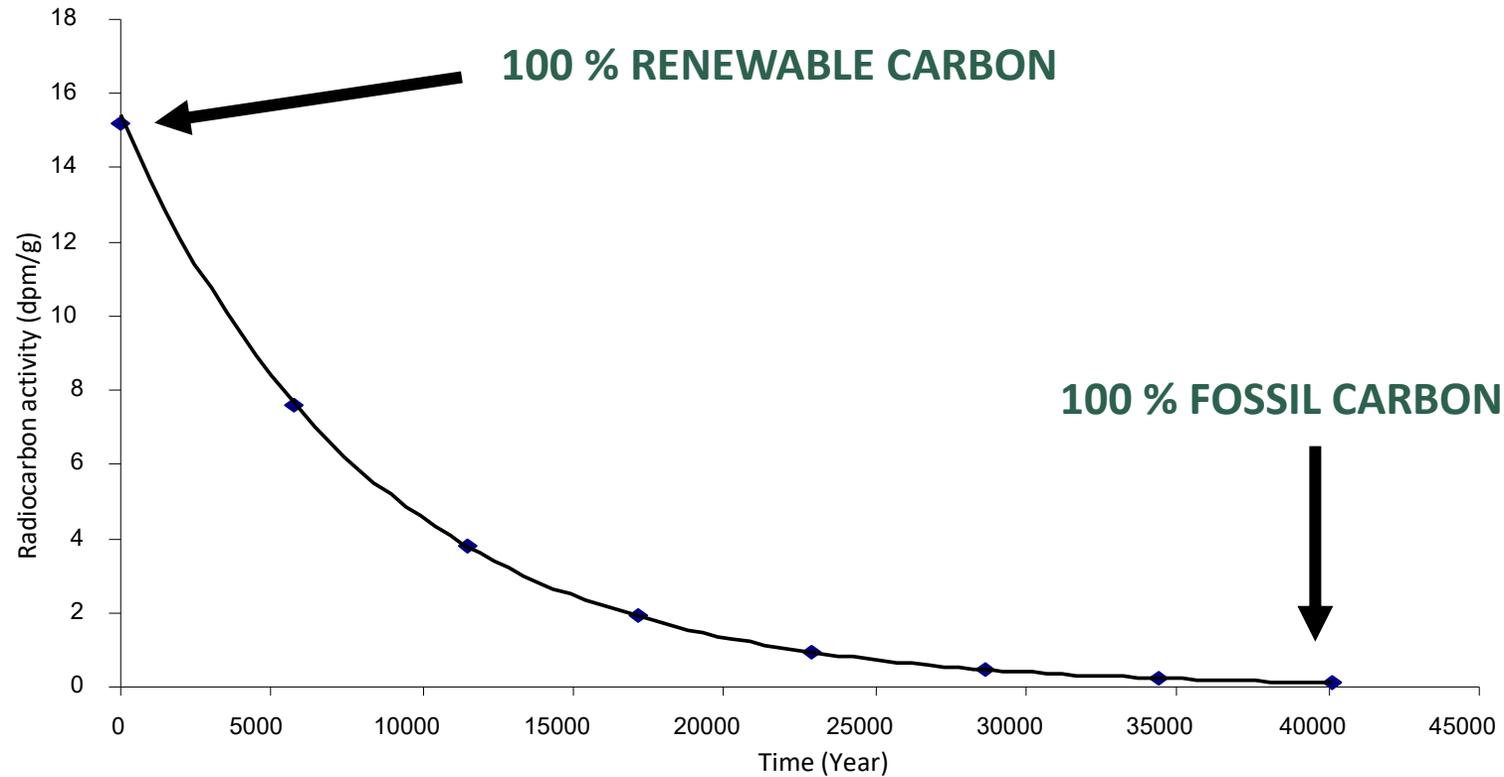
ORIGIN OF 1,3 BUTYLENE GLYCOL VIA EA-IRMS



ANALYTICAL STRATEGIES OF AUTHENTICATION

ASSESSMENT OF RADIOCARBON ACTIVITY

Radioactive activity is measured in disintegrations per minute and per gram of carbon (dpm/g).



ANALYTICAL STRATEGIES OF AUTHENTICATION

ASSESSMENT OF RADIOCARBON ACTIVITY – STUDY CASES

DECETH-3

from 6 suppliers

The Deceth-3 is synthesized from renewable alcohols and fossil oxyethylene moiety. We evaluated at 63 percent rate of renewable carbon.

The rate of fossil carbon measured for suppliers A,B,C,D,E are consistent with the calculated values.

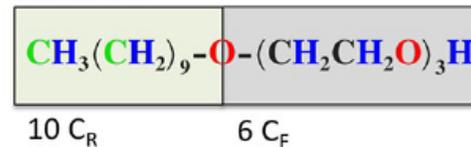
The rate of renewable carbon of two batches of DECETH-3 of Supplier F is not consistent with expected value. The fatty alcohol is essentially fossil. This commercial reference is not conform to their declaration of origin.

The commercial reference from supplier F is not conform to their declaration of origin

EVALUATION OF RENEWABLE CARBON AMOUNT IN DECETH-3 THEORETICAL CALCULATION FROM ORIGIN DECLARATION & CHEMICAL COMPOSITION

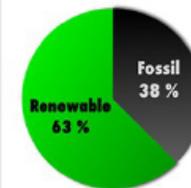
Suppliers A, B, C, D, E

DECETH-3

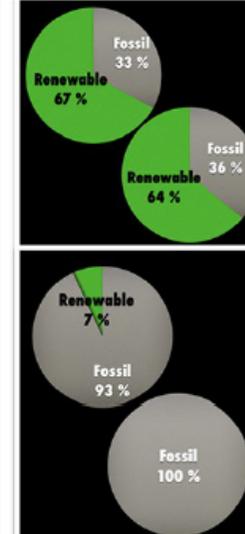


Supplier F

CALCULATED



MEASURE

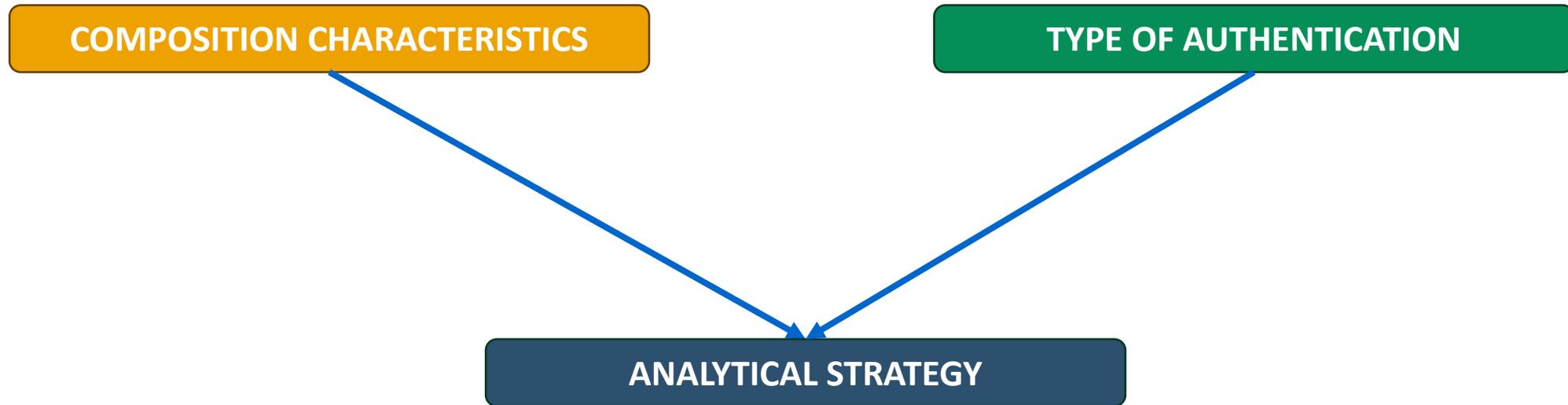


DECETH-3 From Supplier F IS NO CONFORM

ANALYTICAL STRATEGIES OF AUTHENTICATION

SYSTEMATIC PROCESS

Development of a systematic process that reduces analysis times and allows for the selection of the most appropriate analytical method.



ANALYTICAL STRATEGIES OF AUTHENTICATION

SYSTEMATIC PROCESS

Development of a systematic process that reduces analysis times and allows for the selection of the most appropriate analytical method.

COMPOSITION CHARACTERISTICS

Matrix complexity?

Volatile compounds?

Non-volatile compounds?

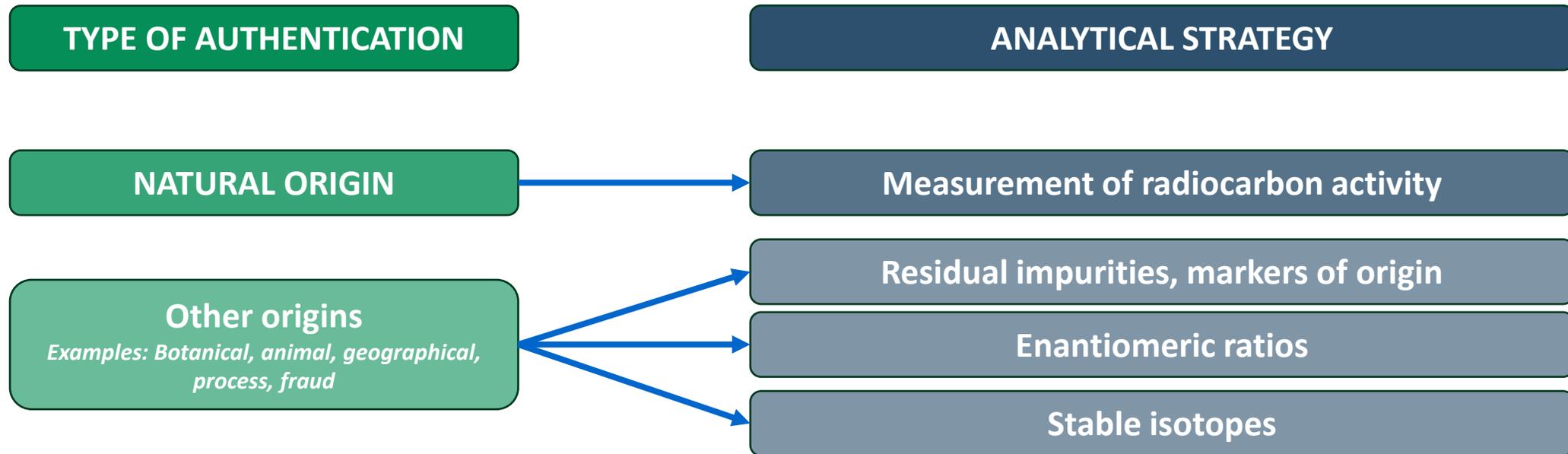
Presence of chiral compounds?

Elemental composition of the constituents

ANALYTICAL STRATEGIES OF AUTHENTICATION

SYSTEMATIC PROCESS

Development of a systematic process that reduces analysis times and allows for the selection of the most appropriate analytical method.



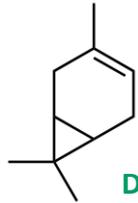
SYSTEMATIC PROCESS APPLICATION



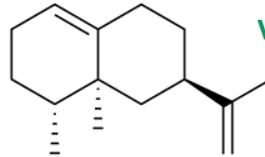
EXAMPLE OF MANDARINE SAMPLE

Volatile Composition (GCxGC-FID/TOFMS)

Identification of orange oil natural markers and abnormal high / low concentration of specific compounds



Delta 3-carene



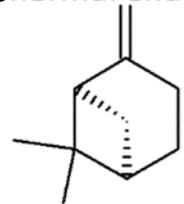
Valencene

Absence of delta 3 carene & valencene in a genuiness mandarin oil

Addition of orange oil

Chiral Analysis (Enantio MDGC)

Abnormal enantiomeric ratios, including the inversion of beta pinene



β -Pinene (R)(+)



β -Pinene (S)(-)

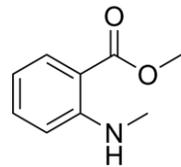
	AUTHENTIC ORANGE	AUTHENTIC LEMON	AUTHENTIC MANDARINE	COMMERCIAL MANDARINE
(+)- β -Pinene	54.0% - 61.0%	4.30% - 6.76%	94.76% - 98.48%	5.62%

Beta pinene enantiomeric ratio indicative of lemon oil addition

Addition of lemon oil

Stable Isotope Ratios (GC-IRMS)

Compound specific isotope ratios $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of MNMA indicative of a petrochemical origin



Methyl N-methylantranilate (MNMA)

	AUTHENTIC MANDARINE	PETROCHEMICAL ORIGIN	COMMERCIAL MANDARINE
$\delta^{13}\text{C}_{\text{MNMA}}$	-32.6‰ - -29.5‰	-30.7‰ - -37.9‰	-36.9‰
$\delta^{15}\text{N}_{\text{MNMA}}$	3.7‰ - 4.7‰	-7.45‰ - 0.6‰	-9.5‰

Addition of petrochemical origin compounds

CONCLUSION & PROSPECTS

ANALYTICAL STRATEGY RECAP

Establishing a systematic process to guide the choice of the best analytical strategy

Time savings

Gain in efficiency and results

Authentication can only be performed using an internal database that includes authentic samples from multiple sources.

Authentication isn't just about analytics.

Sourcing and purchasing departments can obtain information to confirm origin or raise doubts.

