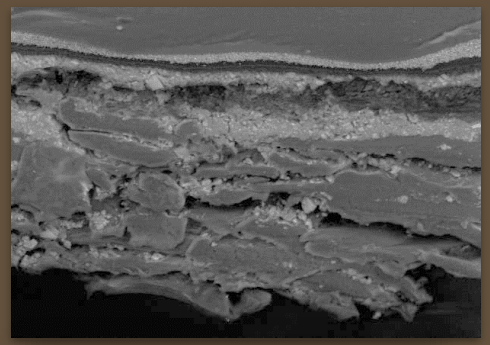
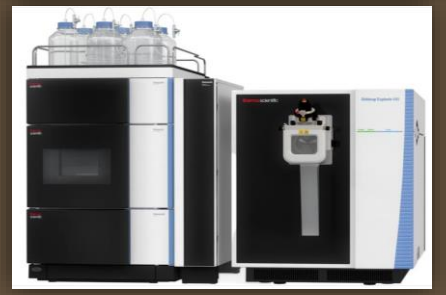
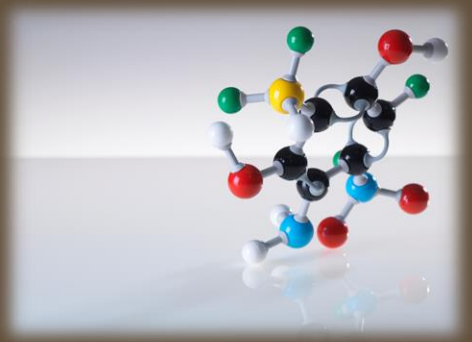
Nestlé Good food, Good life

Improving the identification of unknowns in NIAS screenings

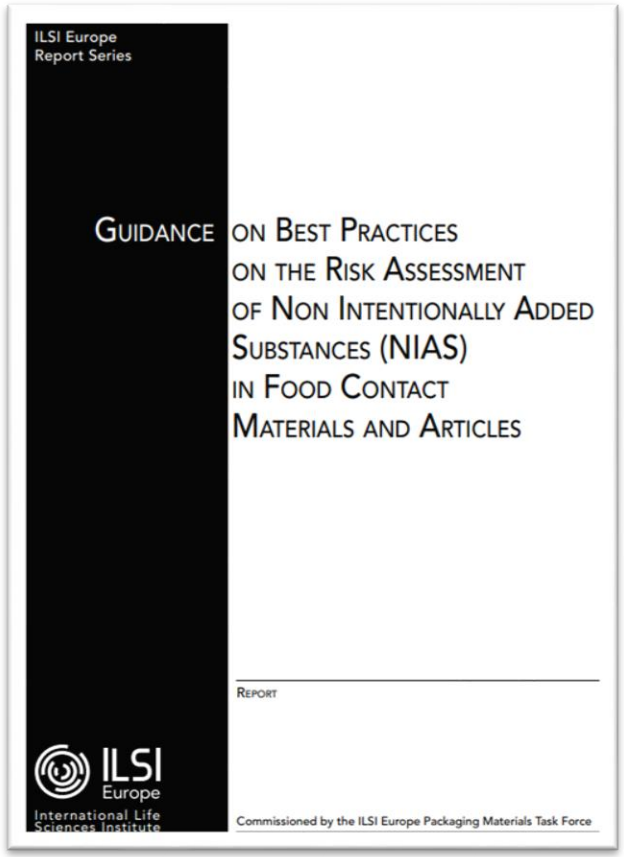




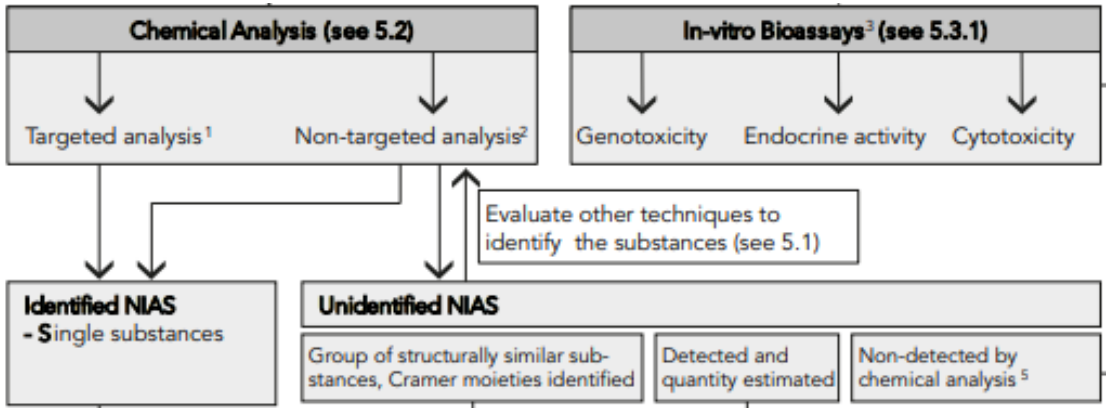


Sander Koster

Investigate: NIAS, a never ending challenge



ILSI 2015



Needed:

- Targeted, suspect and non-targeted screening
- Approach to assess unidentified substances (bioassays)

→ Composition and migration

Research and Development

Composition / Migration : Screening of Food Contact Materials

Novel material → Samples Preparation → GC/LC Analysis → Data Processing

Full assessment
Composition

Assesment of Migration
from FCM to EU food simulants

Chromatography

Identification
semi-quantification

Target / Suspected / Non-Target

Screening

Research and Development

Chemical screening for NIAS: Approach at Nestlé for novel materials

Volatiles	Semi-volatiles	Non-volatiles	Mineral oils
			
Headspace GC-**MS/FID**	Liquid GC-**MS/FID** GC-**HRMS**	Liquid LC-**CAD/HRMS**	LC-GC-**FID/MS** + GCxGC-**FID-MS**

Detectors

MS : Mass Spectrometry
HRMS: High Resolution Mass Spectrometry → Identification

FID: Flame Ionisation
CAD: Charged Aerosol → Semi-quantification

Develop: main challenge in NIAS screening is identification

	Non-targeted screening	Suspect screening	Targeted screening
Aim:	Identify **Unknown** contaminants: - Discover novel & non-expected substances	Identify **Expected** / possible contaminants: - Faster data interpretation	Monitor **known** contaminants (of concerns or banned): - Surveillance plan - Compliance check
How:	• Structural elucidation	• Commercial libraries • In-house libraries • In-silico fragmentation libraries	• Analytical standards • *m/z* parent/fragments • In house libraries • Ion ratio • Retention index/time

Challenges:

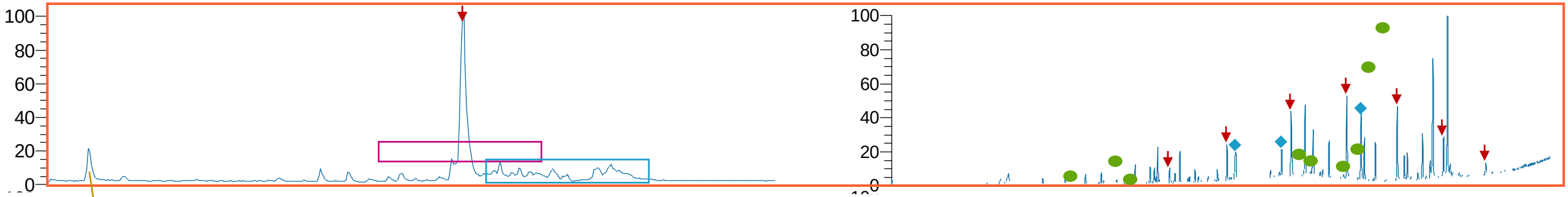
- MS interpretation skills
- Availability standards for confirmation
- Develop consistent/broad libraries

Research and Development

Non-targeted screening case study by LC-HRMS: a biodegradable material

LC-HRMS profiles

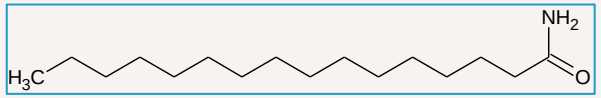
GC-MS profiles



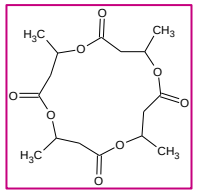
CROSS-LINKING AGENT

SLIP AGENTS

Hexadecanamide

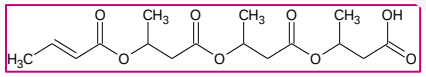


PHBH OLIGOESTERS



or

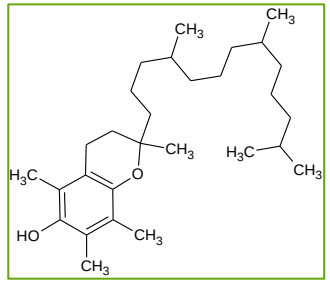
4HB



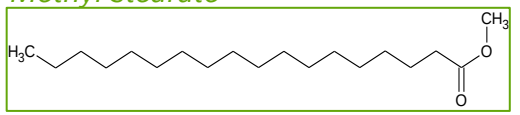
UNKNOWNS

NATURAL SUBSTANCES

Vitamin E



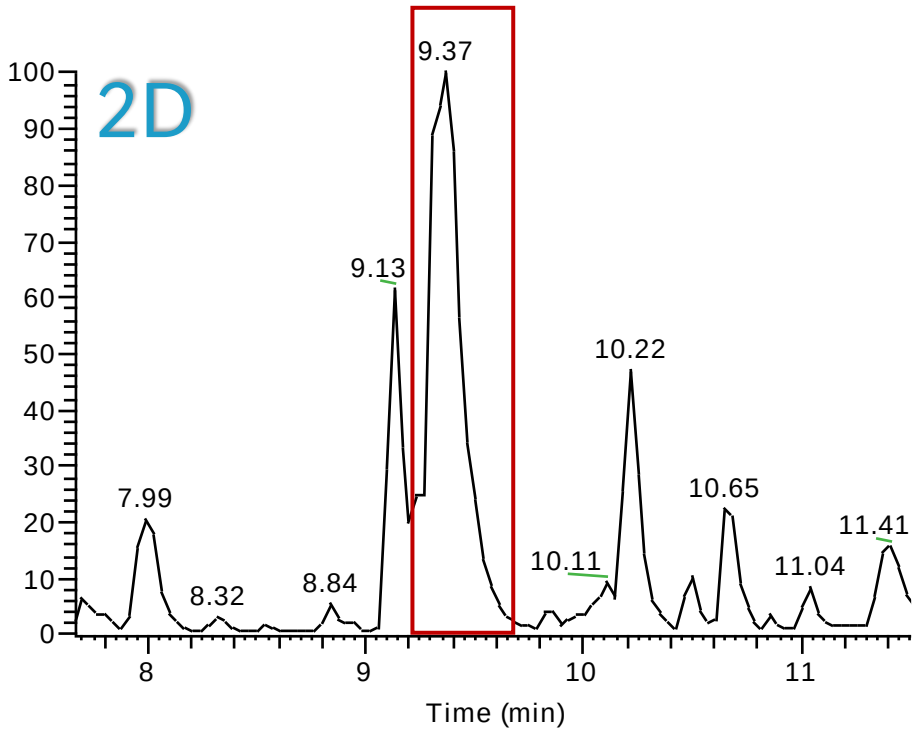
Methyl stearate

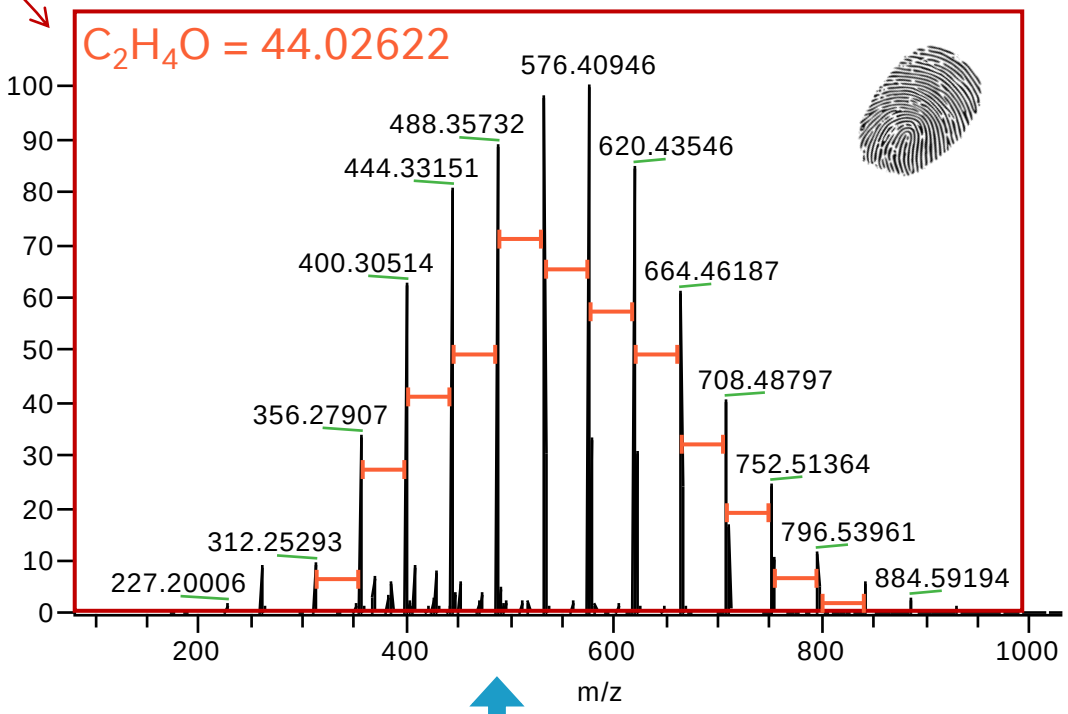


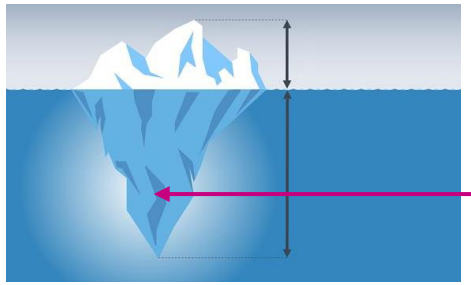
Research and Development

Non-targeted screening case study by LC-HRMS

3rd D = fingerprint







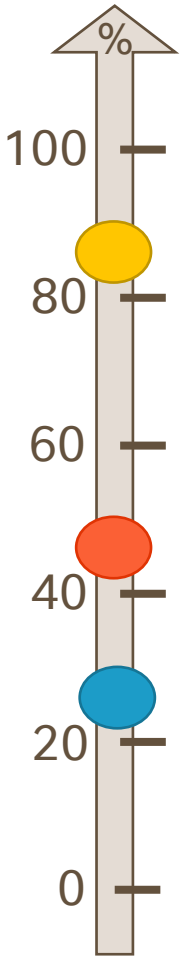
No match with our Packaging Database...

NIAS ?

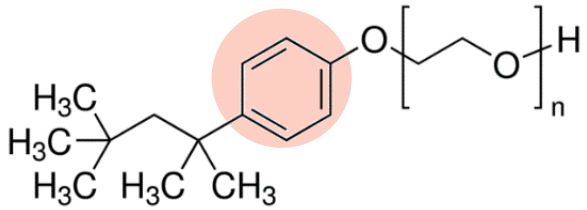
Research and Development

Non-targeted screening case study by LC-HRMS

Level of confidence



Octylphenol, ethoxylated (OPE)



1 - Literature

Analysis of Octyl- and Nonylphenol and Their Ethoxylates in Water and Sediments by Liquid Chromatography/Tandem Mass Spectrometry

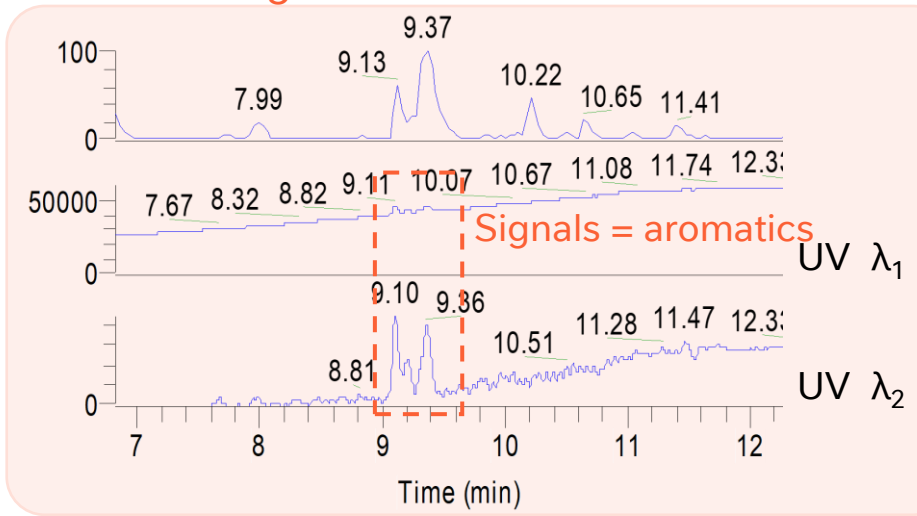
Jorge E. Loyo-Rosales,† Isabelle Schmitz-Afonso,‡ Clifford P. Rice,† and Alba Torrents*,†

Environmental Engineering Program, Department of Civil and Environmental Engineering, University of Maryland, College Park, Maryland 20742, and Environmental Quality Laboratory, ANRI, ARS/USDA, 10300 Baltimore Avenue, Beltsville, Maryland 20705

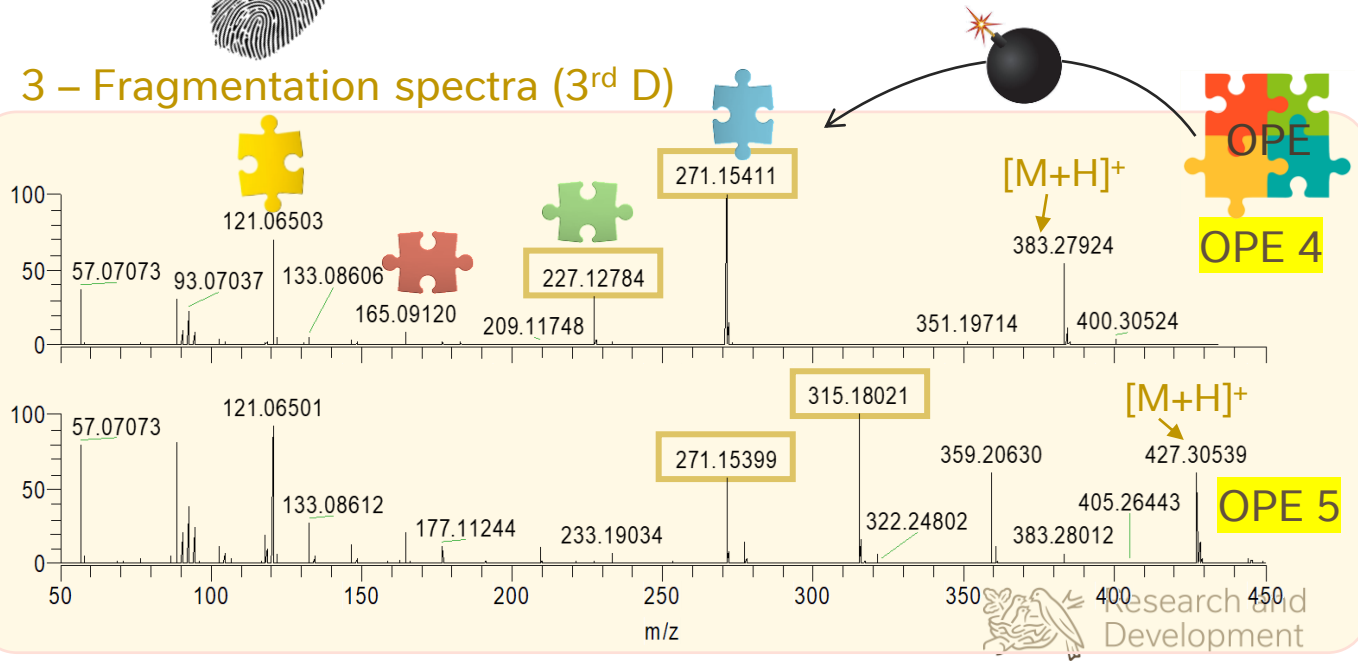
Table 1. Parent and Fragment Ions Used for Quantitation of NP, OP, and Their Respective APnEOs, and MS Parameters Used To Produce Them

compd	parent ion, Da	fragment ion, Da	retention time, min	cone, V	collision, eV	ion mode
NP	219	133	26.4	−40	30	ES−
NP1EO	282	127	24.1	15	10	ES+
NP2EO	326	183	22.7	20	12	ES+
NP3EO	370	227	21.4	20	14	ES+
NP4EO	414	271	20.3	20	15	ES+
NP5EO	458	315	19.3	20	18	ES+
OP	205	133	25.9	−45	20	ES−
OP1EO	268	113	23.5	15	10	ES+
OP2EO	312	183	21.9	20	12	ES+
OP3EO	356	227	20.6	20	13	ES+
OP4EO	400	271	19.5	20	15	ES+
OP5EO	444	315	18.3	25	18	ES+
[^{13}C]-NP	225	139	26.4	−40	30	ES−
[^{13}C]-NP1EO	288	127	24.2	15	9	ES+

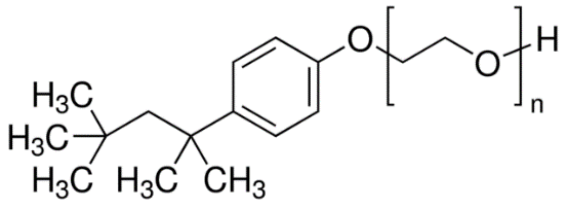
2 – Investigation 2nd detector



3 – Fragmentation spectra (3rd D)

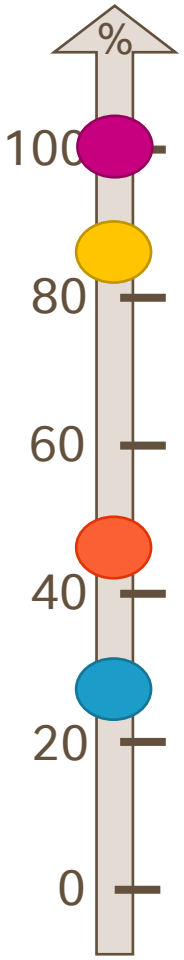


Non-targeted screening case study by LC-HRMS

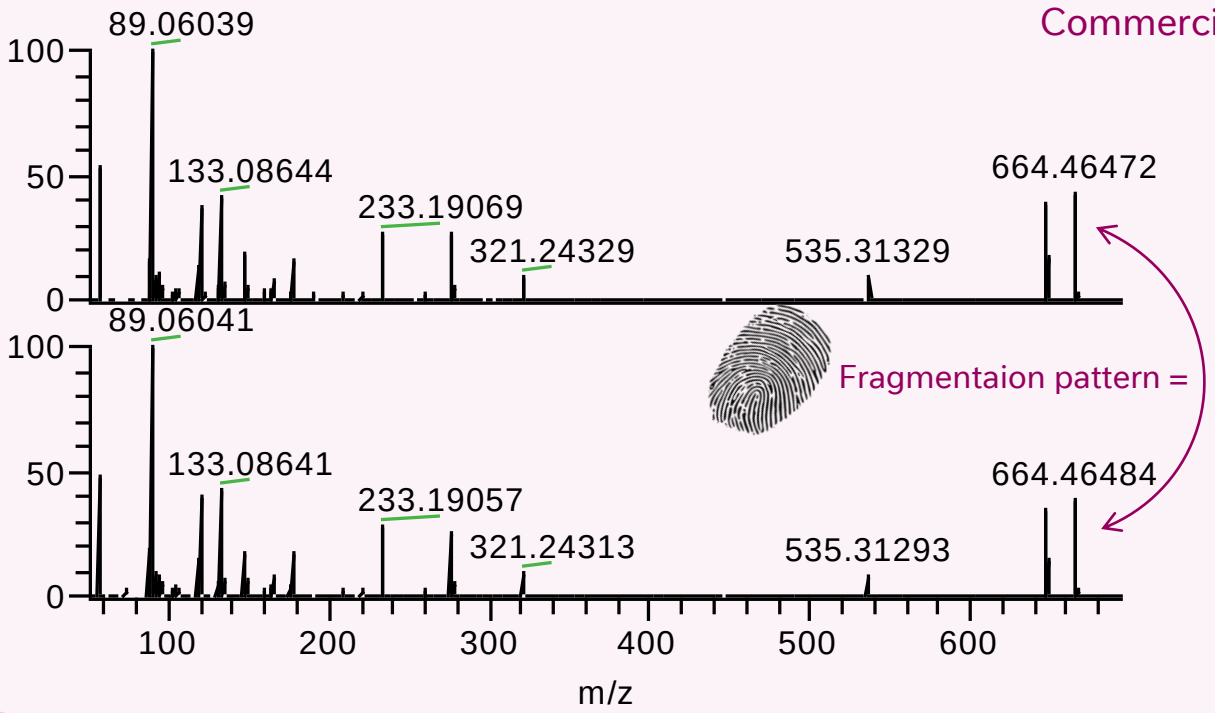


= Surfactant

Level of confidence

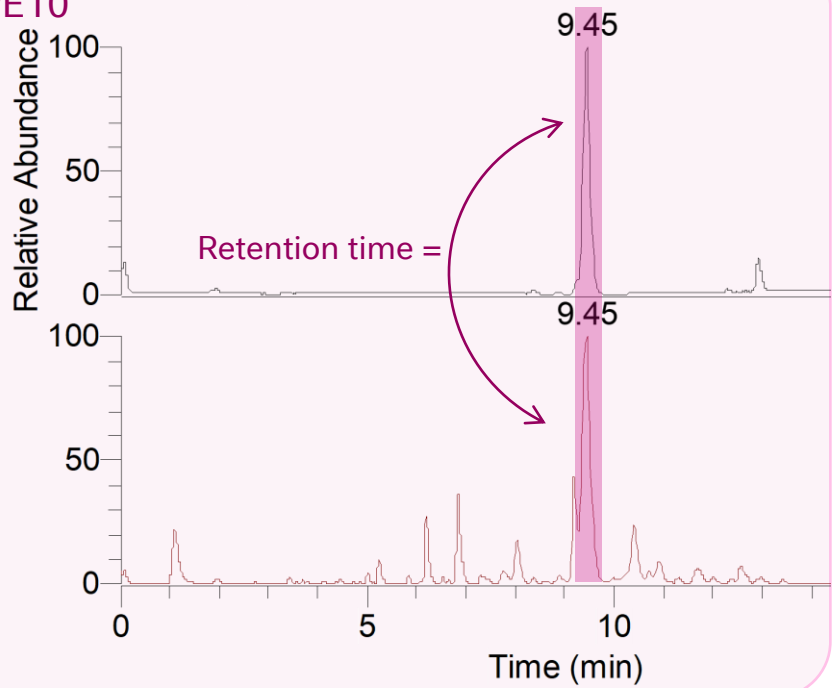


4 – Comparison with commercial standard



Fragmentaion pattern =

Commercial OPE10

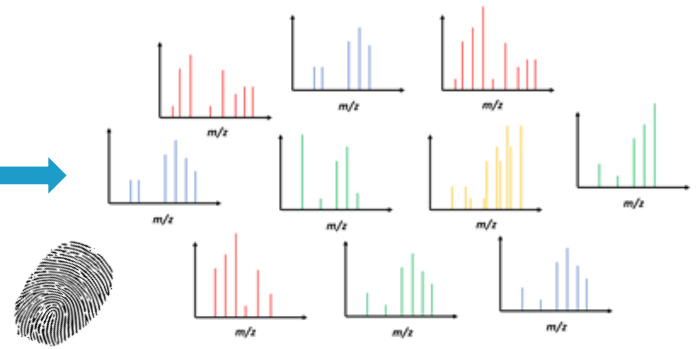


Very time consuming and maybe not always needed?

Research and Development

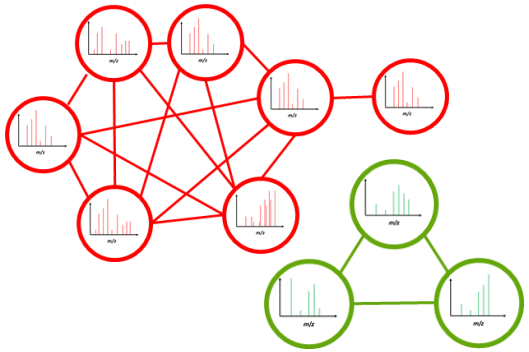
Molecular networking to help identifying unknown chemicals in non-targeted screening: the technology

Mass spectrometry



Fragmentation pattern

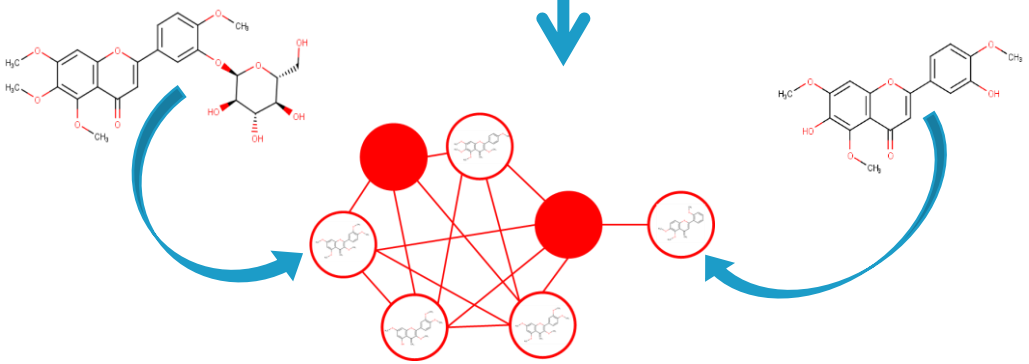
python



Molecular Network
group similar pattern

python

DB query



Compound identification

HOLISTIC approach

Research and Development

Application of Molecular networking approach: blend of bioplastic as a case study

Grade 1

Grade 2

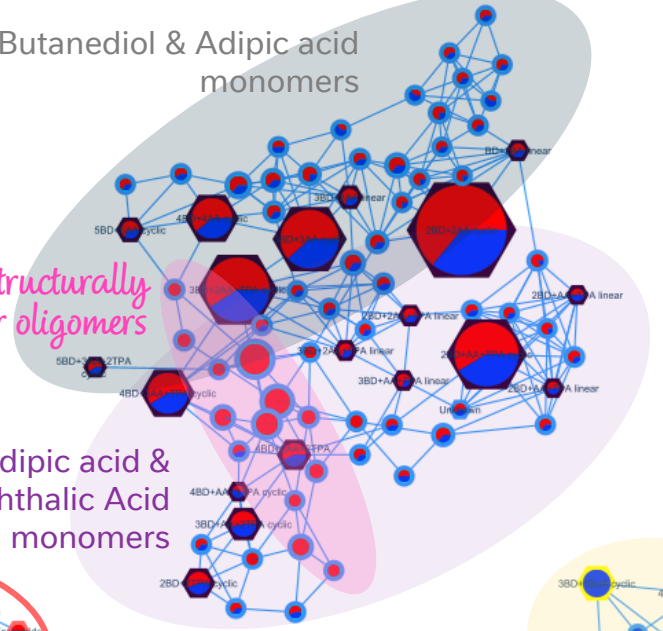
PIE CHARTS: *Proportions in sample types*
NODE SIZE: *Abundance*

POLYBUTYLENE ADIPATE TEREPHTHALATE OLIGOMER

1,4-Butanediol & Adipic acid monomers

New class of structurally similar oligomers

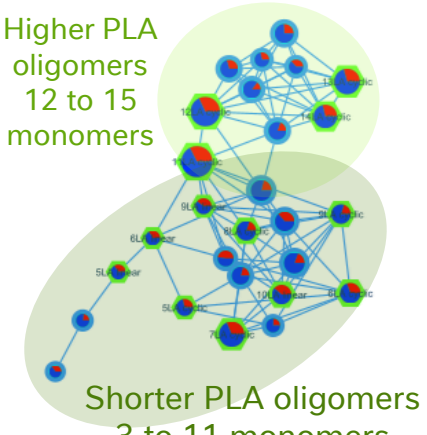
1,4-Butanediol, Adipic acid & Terephthalic Acid monomers

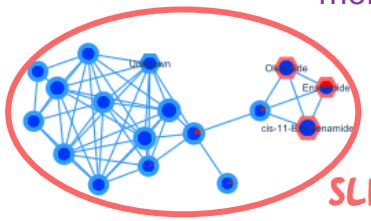


POLYLACTIC ACID OLIGOMERS

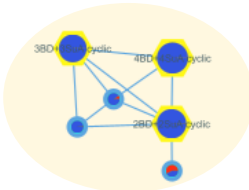
Higher PLA oligomers 12 to 15 monomers

Shorter PLA oligomers 3 to 11 monomers

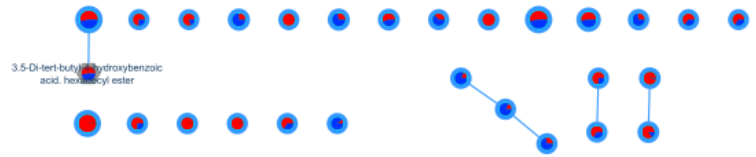




SLIP AGENTS



POLYBUTYLENE SUCCINATE OLIGOMER



- **FASTER** data interpretation
- Identification of **UNKNOWN** chemicals
- '**FOCUS**' on molecules of interest

Summary

Risk assessment requires knowledge on the chemical nature of packaging materials.

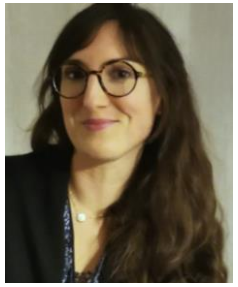
Identity of migrating chemicals may be time consuming to obtain but not always necessary.

Use of molecular networks may in some cases avoid the need for detailed investigation of unknowns.

Improving libraries of chemicals is important even when using molecular networks.

Bioassays may help to conclude on safety of unknowns.

Acknowledgements


E. Omer


Y-A. Hammel


F. Clément


J. Varela


O. Ballahoues