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swiss quality testing services

Food Contact Materials
- Non-Target Screening –

Dr. Thomas Gude

Food Contact Materials

MIGRATION

MATERIAL 1

ADHESIVE

MATERIAL 2

Transfer of substances from the PACKAGE to the FOOD

A Risk for the CONSUMER?

A Risk for the PRODUCER?

Food Contact Materials

Materials and articles, including active and intelligent materials and articles, shall be manufactured in compliance with good manufacturing practice so that, under normal or foreseeable conditions of use, they **do not transfer** their constituents to food in **quantities** which could:

(a) endanger human health; or

(b) bring about an unacceptable change in the composition of the food; or

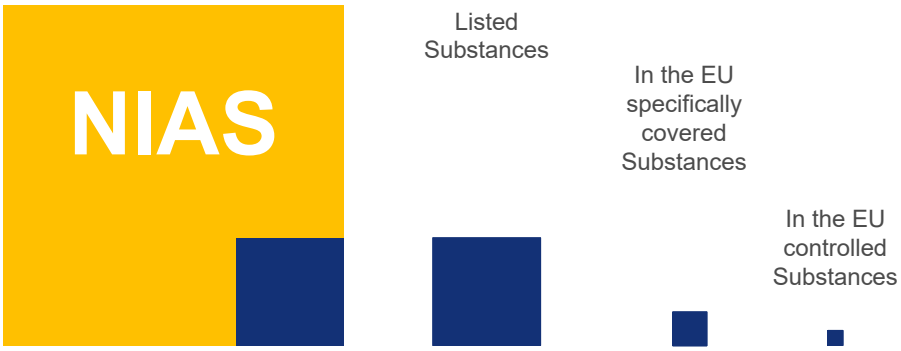
(c) bring about a deterioration in the organoleptic characteristics thereof.

Art.3 Reg. EC 1935/2004

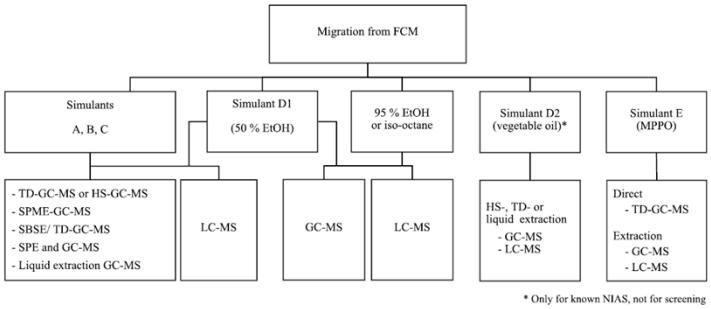
MIGRATABLE SUBSTANCES

INTENTIONALLY ADDED SUBSTANCE - IAS	NON INTENTIONALLY ADDED SUBSTANCES- NIAS
Monomers and catalysts, aids to polymerization (in PLASTICS)	Reactions and degradation products
Additives and coadjuvants (antioxidants, lubrificants, dyes, fillers, etc)	Impurities of the raw materials
Inks, adhesives, etc.	Contaminants

Non-Intentionally Added Substances (NIAS)



The Testing

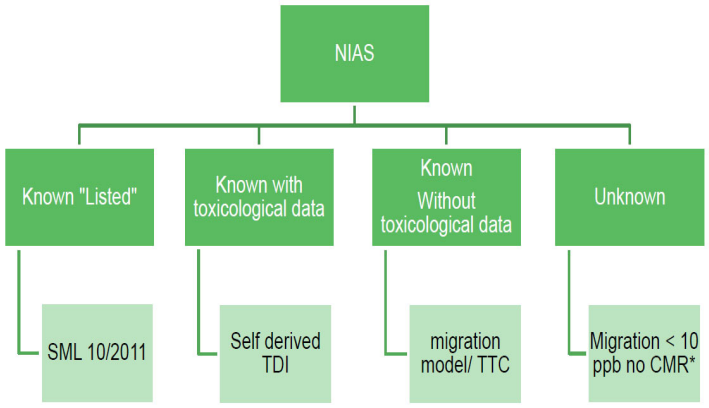


HS static headspace
TD thermal desorption from FCM or adsorbent (e.g. MPPO) or purge and trap or dynamic headspace
SBSE stir bar sorptive extraction
SPME solid phase microextraction

Systematic NIAS
- Fingerprint of a material
- The source can be identified
- A risk assessment is needed

Random NIAS (non intended contaminations)
- More linked to uncontrolled contaminations
- Difficult to monitor
- No immediate action

NIAS- Assessment



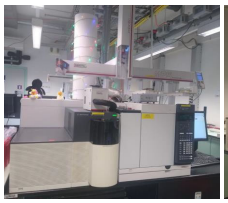
*When migration < 10 ppb, no further considerations are necessary dependent on exclusion of CMR substances based on expert judgement. http://fca.cefic.org/images/Documents/FCA.pdf

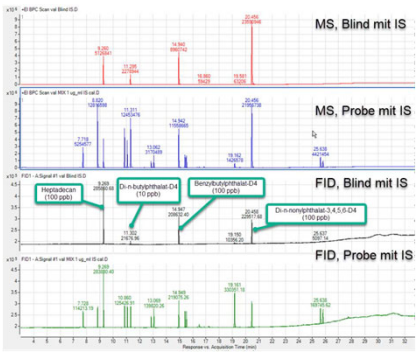
GC-QTOF-MS/FID-Screening

- Start of GC-QTOF-MS/FID screenings in 2010 with initial R&D questions
- Today: Bottleneck large number of screenings per day
- evaluate

- Agilent 7890B Network GC with FID,
- Gerstel PTV injector, Agilent 7200 GC/MS-QTOF

- Principle:
- Quantification: via FID
- Identification: via MS

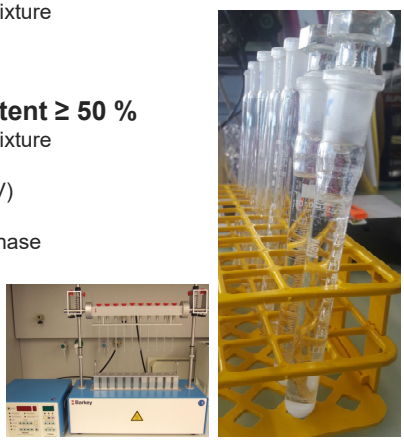




GC-QTOF-MS/FID sample preparation

- **Migration solutions with organic content > 70 %**
  10 ml migration solution spiked with 10 µl IS mixture
  evaporation at 60°C with N_2 to 1 ml

- **Migration solutions with water content ≥ 50 %**
  10 ml migration solution spiked with 10 µl IS mixture
  add a small amount of NaCl with a spatula
  add 1.0 ml ethyl acetate / cyclohexane 1:1 (V:V)
  shake for 30 min at room temperature
  wait 10 min for settlement and inject organic phase



Supplement to GC-MS screening

- The topic of LC also comes up: do you see “all” NIAS in GC-MS screening?

GC	Both	LC
ATBC and degradation products Polyester Oligomers Terpenoids Hydrocarbons Glycerides Fatty acids, fatty acid esters, Fatty acid amides Phthalates, DINCH Degradation products of photoinitiators siloxanes	Antioxidants and their degradation products caprolactam nonylphenol	aromatic amines Isothiazolinones (biocides) BPA, BADGE Nitrosamine Acrylate (ACR) Photoinitiators (PI) Soluble pigments Ethoxylated and propoxylated PI and ACR polyamide oligomers PEG, PEG alkyl ether docusate dioctyl sulfosuccinate

LC-MS screening

- Two LC-QTOF-MS screens have been developed

- **System 1**: Waters Synapt G2-S with I-Class UPLC
- **System 2**: Agilent 6546 Series Q-TOF LC-MS System with 1290 Infinity II System (UPLC)

- Transferred experience from GC-MS screening
- Inspired by suspect and non-target screenings of organic trace substances in the environment, ETH, EAWAG, EMPA
- Start with targeted multimethods for acrylates and Photoinitiators (for chromatography and MS)

- LOD: 10 µg/kg food (for non-CMR)
  → 1.7 µg/dm2 packaging (EU cube 6 dm2/kg food)
  → 17 µg/l (target LOD 10 µg/l)

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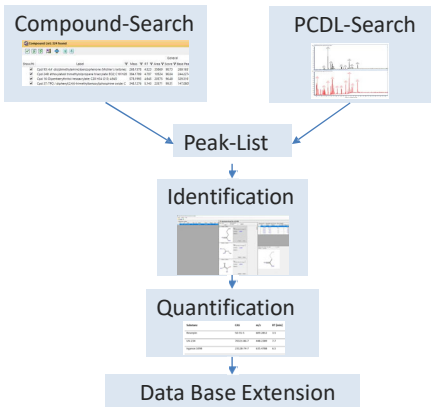
Process of the Evaluation



Personal
Compound
Database and
Library Manager

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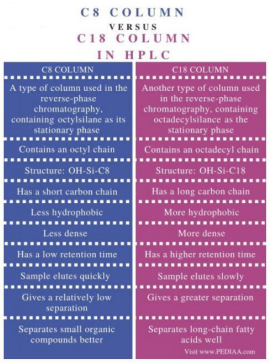
LC-QTOF-MS-SCR

Chromatography:

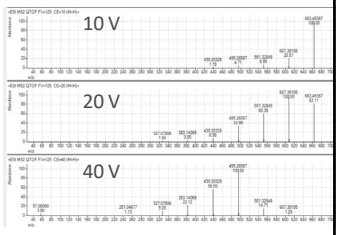
- Eluent: ACN vs. methanol, Column: C8 vs. C18
- Gradient inherited from previous method

Mass Spectrometry:

- QTOF-MS, full scan (m/z 50-1200)
- 60,000 resolution (FWHM at m/z 1522), 38,000 (FWHM at m/z 118)
- Mass accuracies < 1 ppm
- Library: spectrum library, fragment ions (MS/MS), multiple species, multiple collision energies (e.g. 10, 20 and 40 V), in-house database: many compounds with spectra
- Database: compound database, precursor ions, Molecular formula, monoisotopic mass, RT, structure, do not enter individual adducts In-house database: **over 4500 FCM substances read in on LC and GC**
- Structure via Mol-File from ChemSpider or ChemSketch

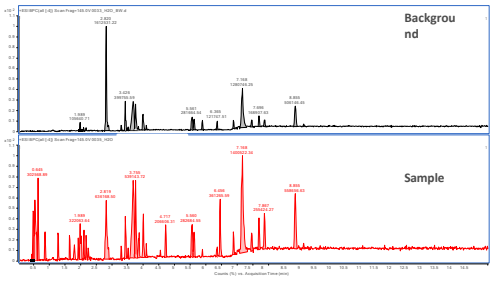


Quelle: https://pediaa.com/what-is-the-difference-between-c8-and-c18-column-in-hplc/



LC-QTOF-MS-SCR: Evaluation

- Automated PCDL scan. Record and quantify substances identified by the PCDL (find by formula) Challenge: subtract blank values, set criteria.

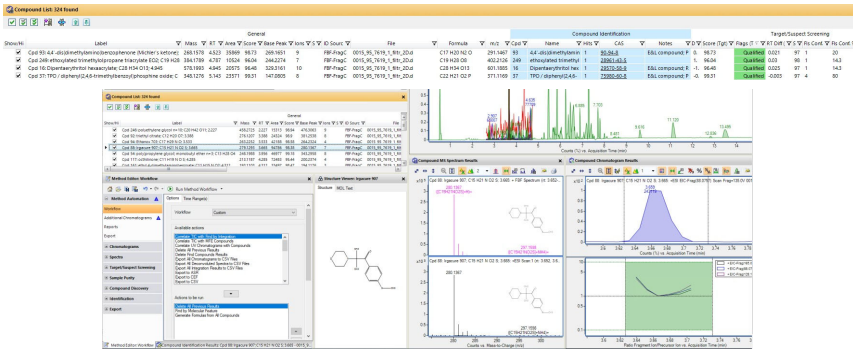


From the evaluation software to Excel for more flexibility:

	A	B	C	D	E	F	G	H	I
1	CAS	Name	RT	Area	Mass	m/z	RT Diff.	Saturate	File
2	25322-68-3	<polyethylene glycol n=10>	2.17	64'013	458.2728	476.3067	-0.052	0	0032_H2O_BW_1ul.d
3	25322-69-4	<polypropyleneglycol n=4 >	2.47	85'703	250.1781	251.1856	-0.047	0	0032_H2O_BW_1ul.d
4	23601-39-0	<pentaethyleneglycol monobutylether>	2.54	60'025	294.2042	295.2115	0	0	0032_H2O_BW_1ul.d
5	25322-69-4	<polypropyleneglycol n=5 >	2.80	140'164	308.2198	309.2272	-0.055	0	0032_H2O_BW_1ul.d
6	143-07-7	<lauric acid (ABL)>	2.80	451'138	200.1778	218.2116	0	0	0032_H2O_BW_1ul.d

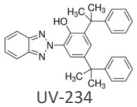
LC-QTOF-MS-SCR: Evaluation

- Compound search: Automatically extract compounds that are detectable via LOD but have not been identified by the PCDL (Find by Molecular Feature). Detected compounds: characterized by precise mass, adduct, retention time. Generate possible sum formulas using the Formula Generator, otherwise 'unknown'. Challenge: deduction of blank values, search criteria, empirical formula criteria, don't lose track.

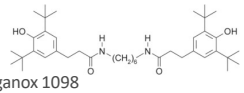


LC-QTOF-MS-SCR: Quantification

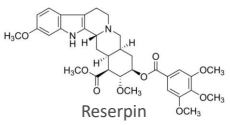
- POS: mean of the areas of the external standards reserpine and UV-234 (rather "real" case than worst case as with urethane acrylate)
- NEG: the area of the external standard Irganox 1098



UV-234



Irganox 1098



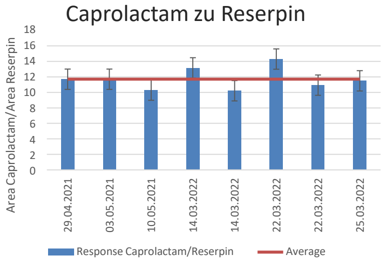
Reserpin

Substanz	CAS	m/z	RT [min]
Reserpin	50-55-5	609.2812	3.5
UV-234	70321-86-7	448.2389	7.7
Irganox 1098	23128-74-7	635.4788	6.5

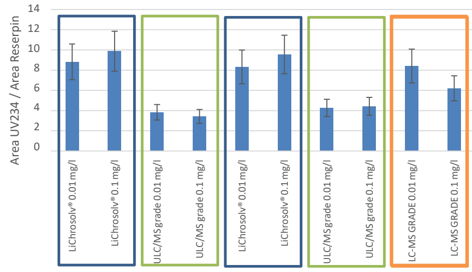
LC-QTOF-MS-SCR: Quantification

- Response factors: Constance monitoring
- Beware of different ACN brands: may affect response

Response von Caprolactam zu Reserpin



Response from UV 234 to reserpine, same reference sample, different CAN brands as eluent



LC-MS-Screening: Validation

- Validation analogous to a target method
- 13 reference substances over the entire m/z and retention time range

Selectivity Decision Limit Lab Precision Robustness
Repeatability Specifity Measurement Uncertainty
LOD, LOQ Concentration Range Trueness Comparability

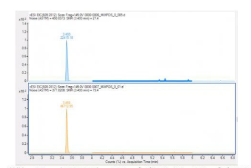
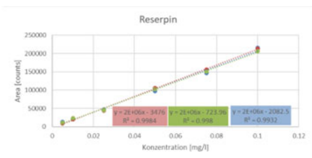


Abbildung 2 Reserpin ESI POS; Oben: 0.005 mg/l, S/N 27.4; Unten: 0.01 mg/l S/N 79.4.

	pos, STS-00795	pos, STS-03695	pos+neg,STS-00550	pos+neg, STS-00555	pos, STS-00274	pos, STS-00224	pos+neg, STS-00502	Pos, STS-00201	Pos, STS-00421	Neg, STS-00219	Neg, STS-00241	neg, STS-00267	pos+neg, STS-00256
Acetonitril	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
95 % Ethanol	n.d.	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
50 % Ethanol	n.d.	n.d.	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
20 % Ethanol	n.d.	n.d.	n.d.	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
10 % Ethanol	n.d.	n.d.	n.d.	n.d.	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
3 % Essigsäure	n.d.	n.d.	n.d.	n.d.	n.d.	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Wasser (Milipore)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Isopropanol	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d	n.d.	n.d.	n.d.	n.d.	n.d.
Hexan	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d	n.d.	n.d.	n.d.	n.d.



Most Recent Publication

FOOD ADDITIVES & CONTAMINANTS: PART A
https://doi.org/10.1080/19440049.2021.2012599

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REVIEW

OPEN ACCESS Check for updates

Guidance in selecting analytical techniques for identification and quantification of non-intentionally added substances (NIAS) in food contact materials (FCMS)

Cristina Nerín[a], Siméon Bourdoux[b], Birgit Faust[c], Thomas Gude[d], Céline Lesueur[e], Thomas Simat[f], Angela Stoermer[g], Els Van Hoek[h], and Peter Oldring[i]

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ABSTRACT
There are numerous approaches and methodologies for assessing the identity and quantities of non-intentionally added substances (NIAS) in food contact materials (FCMs). They can give different results and it can be difficult to make meaningful comparisons. The initial approach was to attempt to prepare a prescriptive methodology but as this proved impossible; this paper develops guidelines that need to be taken into consideration when assessing NIAS. Different approaches to analysing NIAS in FCMs are reviewed and compared. The approaches for preparing the sample for analysis, recommended procedures for screening, identification, and quantification of NIAS as well as the reporting requirements are outlined. Different analytical equipment and procedures are compared. Limitations of today's capabilities are raised along with some research needs.

ARTICLE HISTORY
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KEYWORDS
Food contact materials; migration; food packaging; plastics; non-intentionally added substances; NIAS; chromatographic methods

«The» Solution of a complex problem

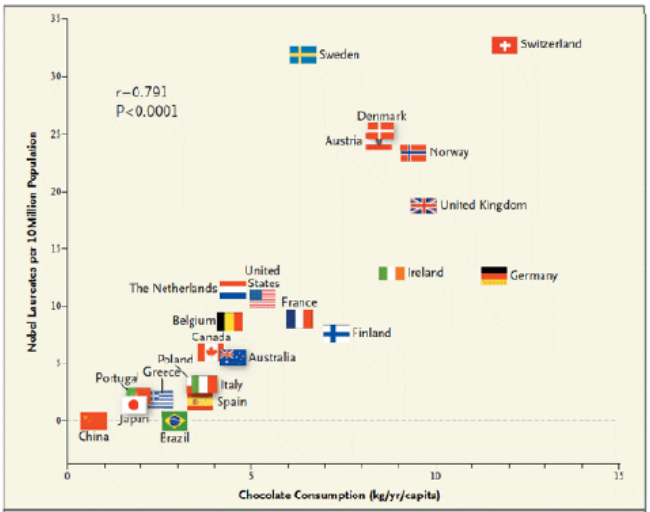

Figure 1. Correlation between Countries' Annual Per Capita Chocolate Consumption and the Number of Nobel Laureates per 10 Million Population.

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