

What is in our packaging? Toxicity and chemicals leaching from plastics

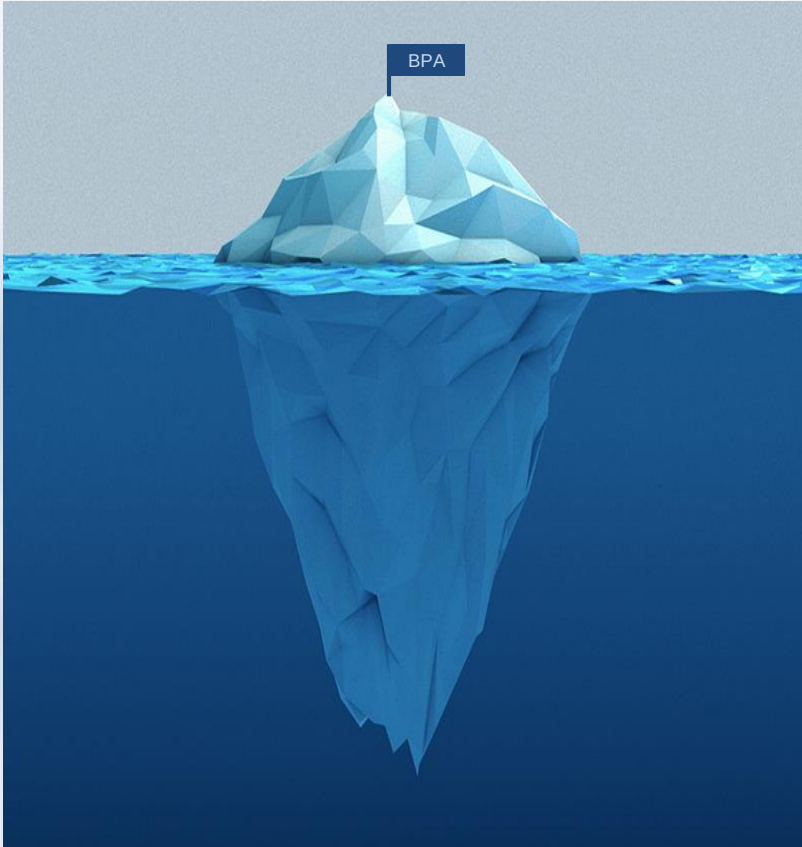
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NTNU Trondheim, Norway

Food contact materials: Is there a problem?



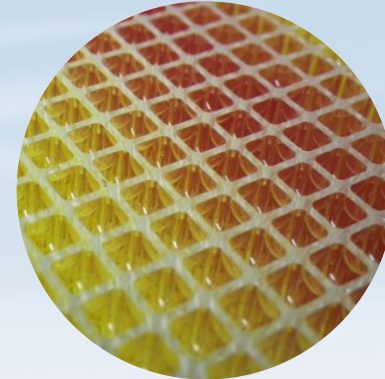
Food packaging: An iceberg problem



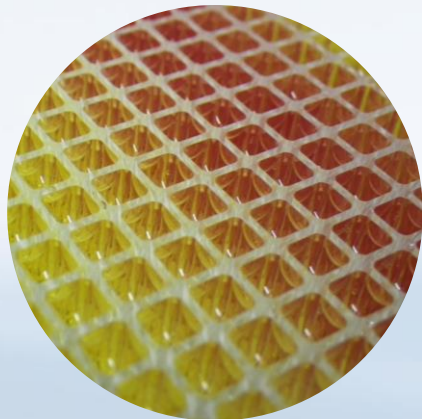
Ways to melt the iceberg

chemical analysis:
known target
compounds

bioassays:
integrate
effects of
known
+ unknown
+ mixtures



Bioassays and consumer products

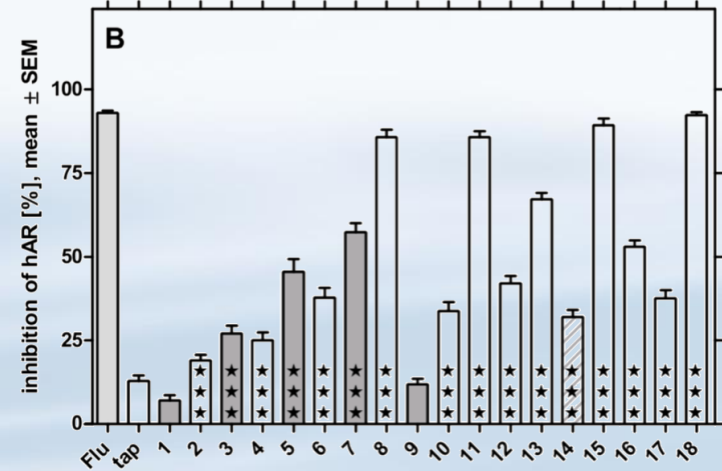
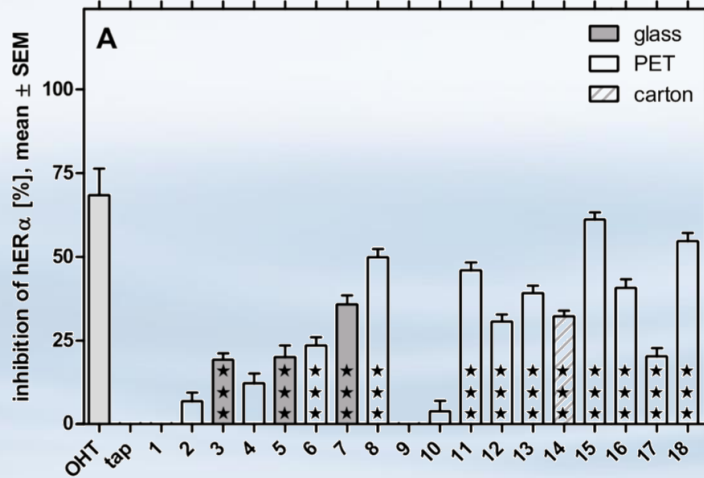


- mostly for Endocrine Disrupting Chemicals (EDCs)
- focus on estrogenic and antiandrogenic MoA
- effect-directed analysis → ID causative compounds



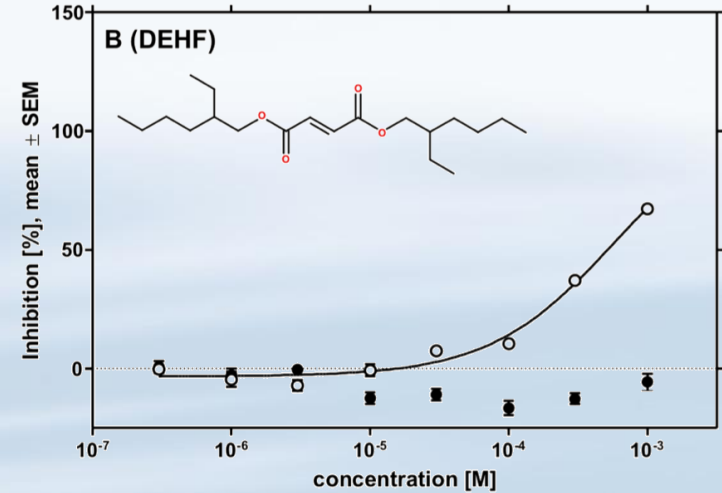
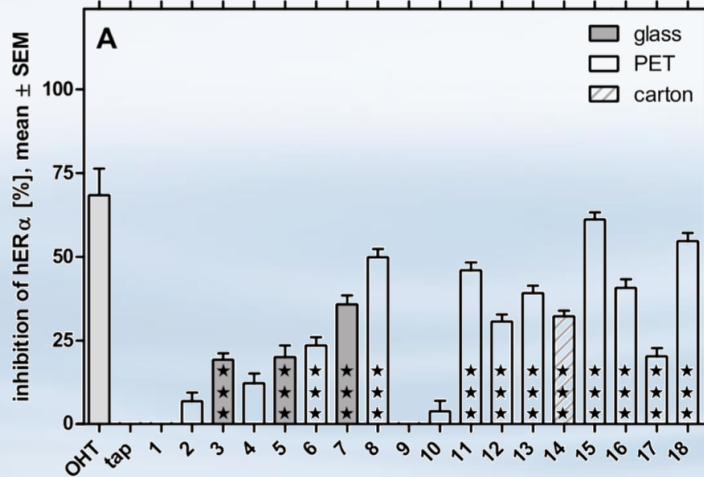
(Guart et al., 2013; Berger et al., 2015; unpublished data)

EDCs in bottled water



(Wagner et al., 2013 Plos ONE)

EDCs in bottled water



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REGULATIONS

REACH CLP BPR PIC

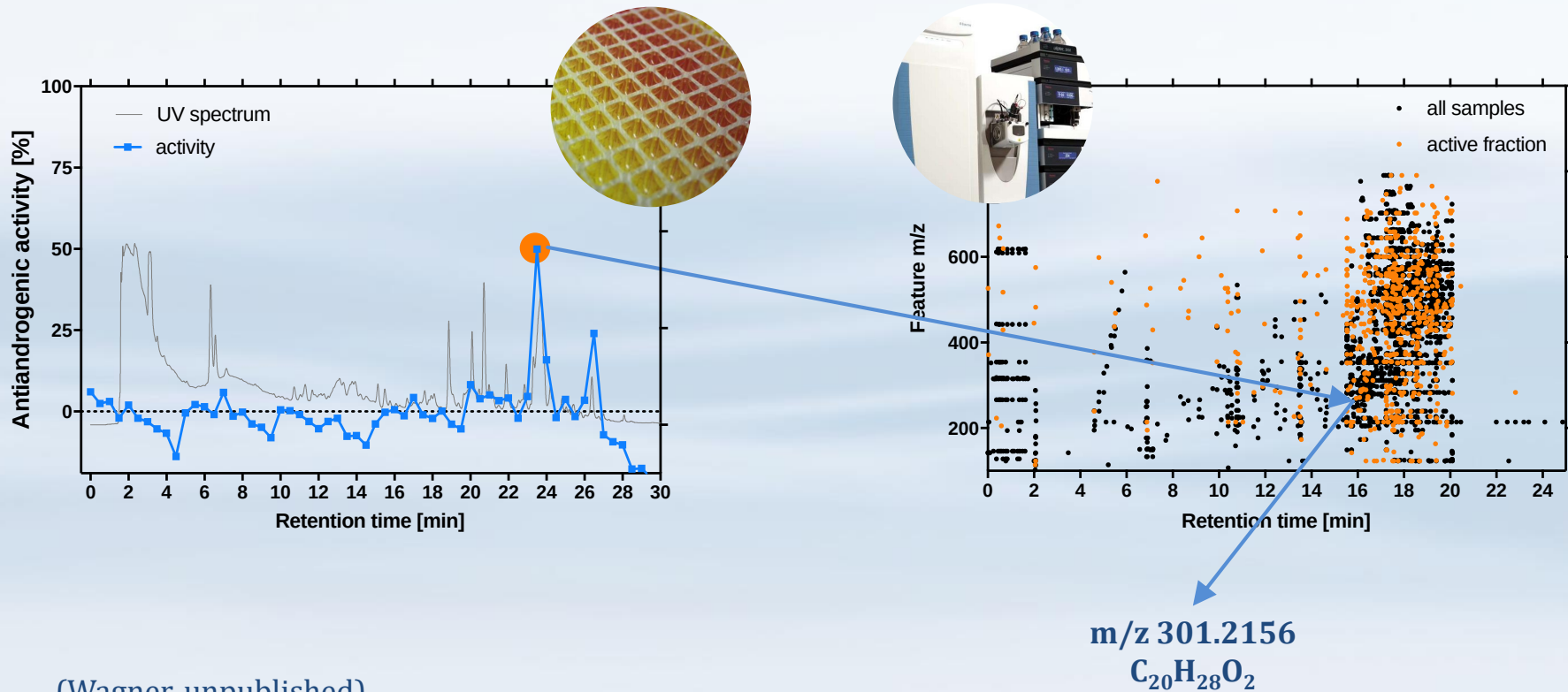
PUBLIC CONSULTATIONS INFORMATION ON CHEMICALS SUPPORT

Formulation or re-packing

This substance has an industrial use resulting in manufacture of another substance (use of intermediates). Release to the environment of this substance can occur from industrial use: formulation of mixtures, manufacturing of the substance, as an intermediate step in further manufacturing of another substance (use of intermediates) and for thermoplastic manufacture.

(Wagner et al., 2013 Plos ONE)

Bottled water: Effect-directed analysis



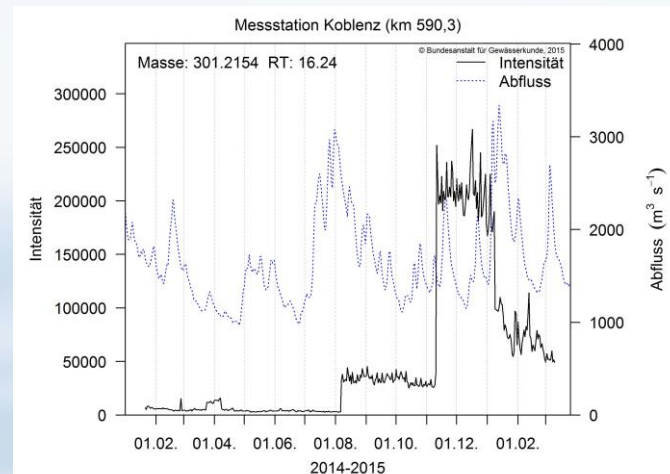
(Wagner, unpublished)

Bottled water: Dealing with unknowns



m/z 301.2156
 $C_{20}H_{28}O_2$

ChemSpider					
Search and share chemistry					
Found 916 results					
Search term: MF = 'C ₂₀ H ₂₈ O ₂ '					
ID	Structure	Molecular Formula	Molecular Weight	# of	
392618		C ₂₀ H ₂₈ O ₂	300.4351		
4445539		C ₂₀ H ₂₈ O ₂	300.4351		
395778		C ₂₀ H ₂₈ O ₂	300.4351		
6061		C ₂₀ H ₂₈ O ₂	300.4351		
85184		C ₂₀ H ₂₈ O ₂	300.4351		



(Wagner, unpublished; Schlüsener, unpublished)

Toxicity in plastics



Products

Drink bottles

Yoghurt cups

Trays/Boxes

Films/Bags

Shampoos

Others



Plastic types

PET

HDPE

LDPE

PS

PP

PUR

PVC

PLA

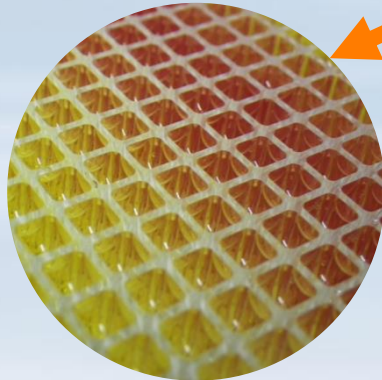
Petrol-based

Bio-based

Additive content

(Zimmermann, unpublished)

Toxicity in plastics

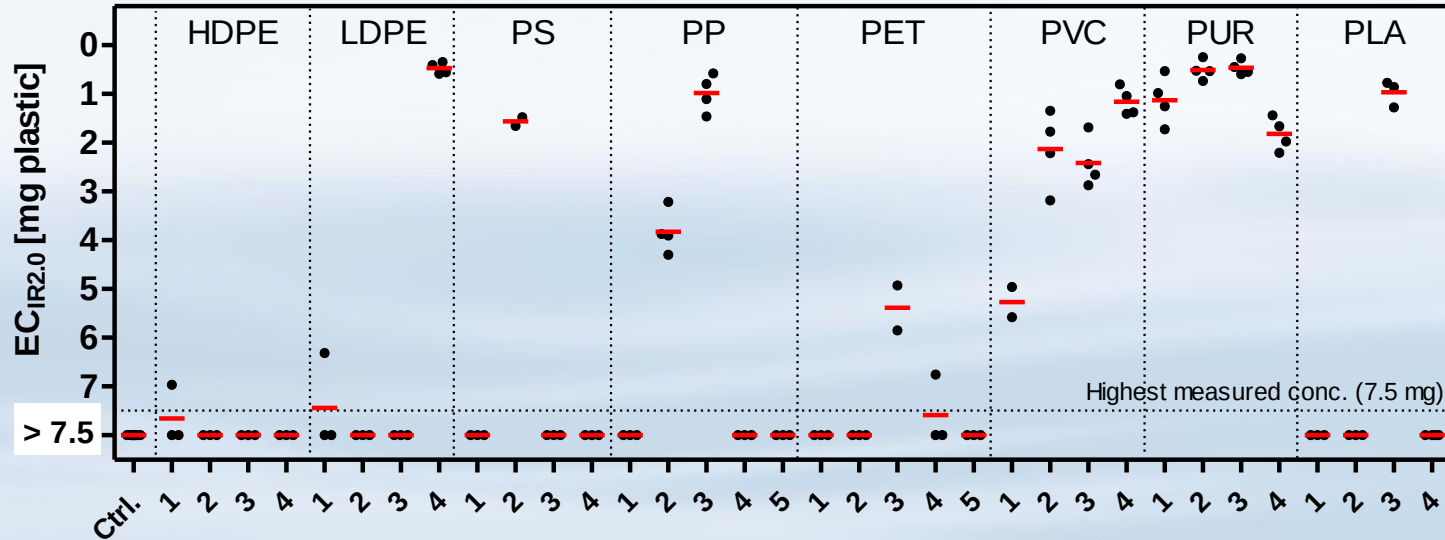


baseline toxicity
oxidative stress
estrogenicity
antiandrogenicity

non-target GC-QTOF-MS

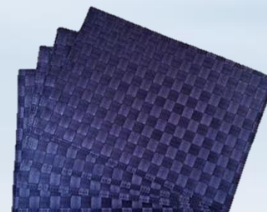
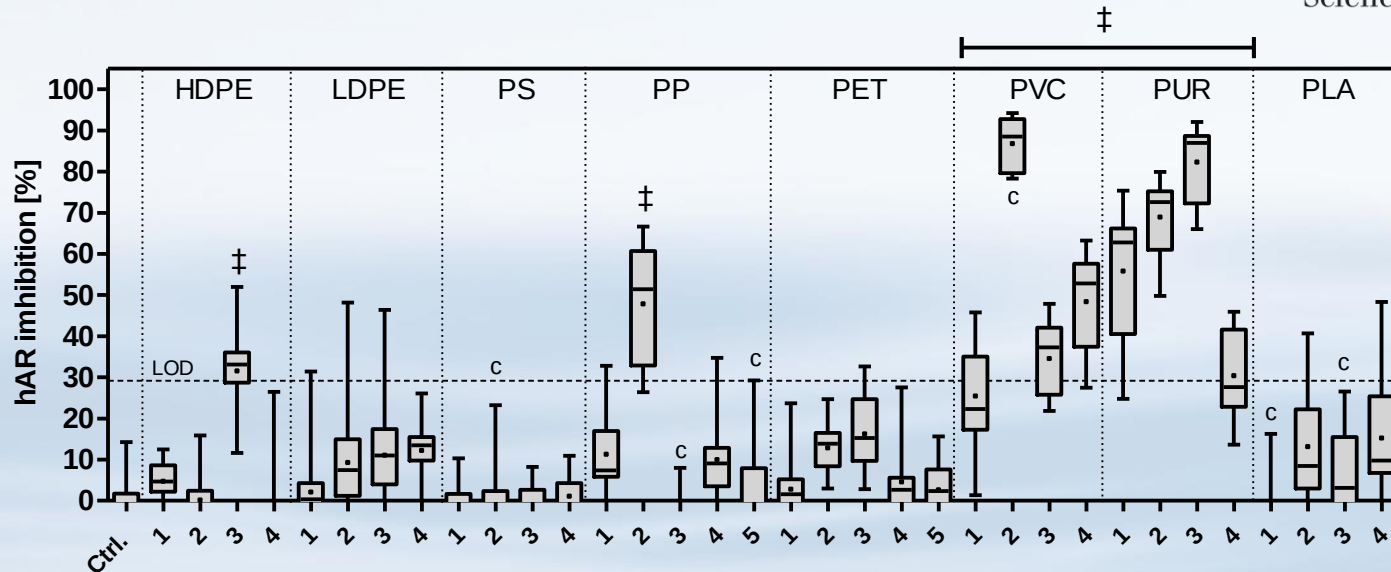


Oxidative stress induction in plastics



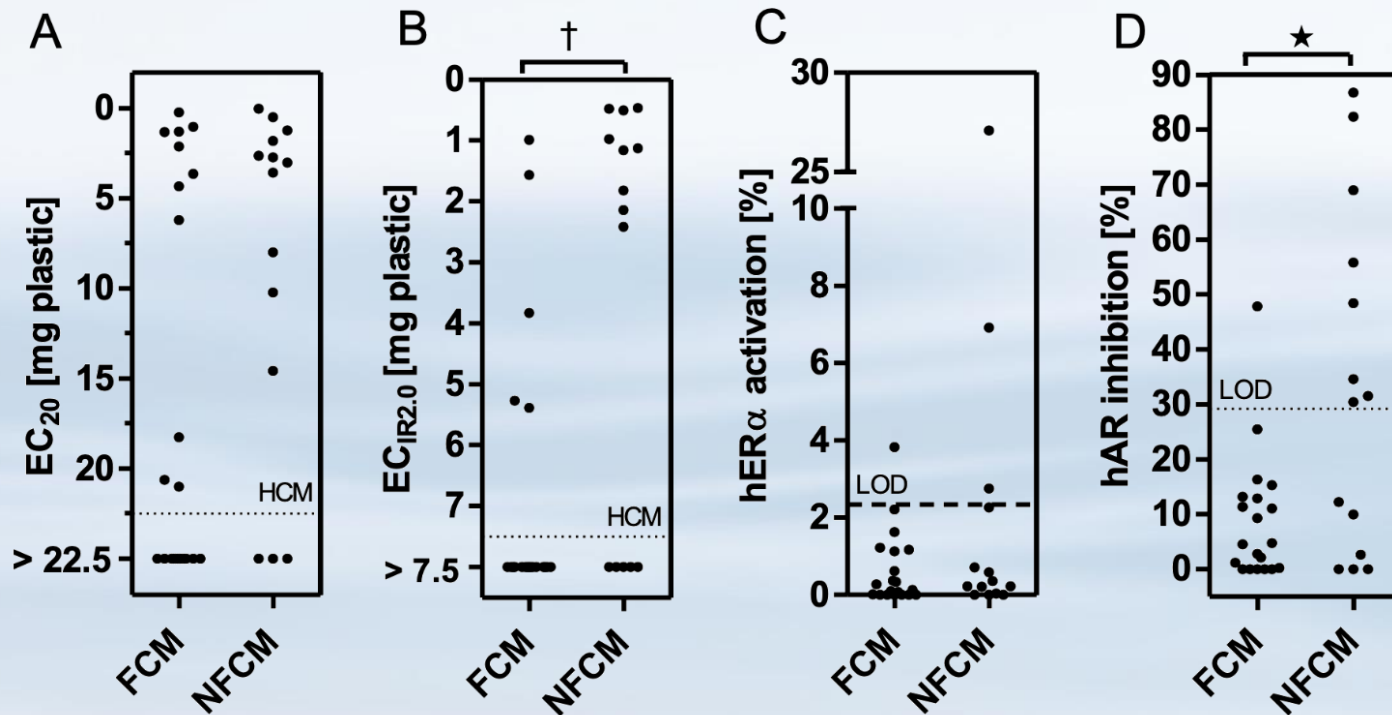
(Zimmermann, unpublished)

Antiandrogens in plastics

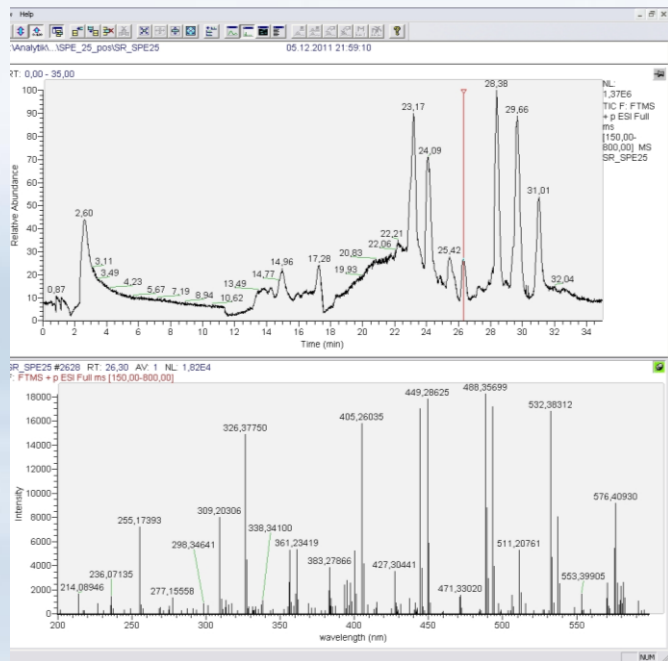


(Zimmermann, unpublished)

Toxicity in plastics: Food contact?



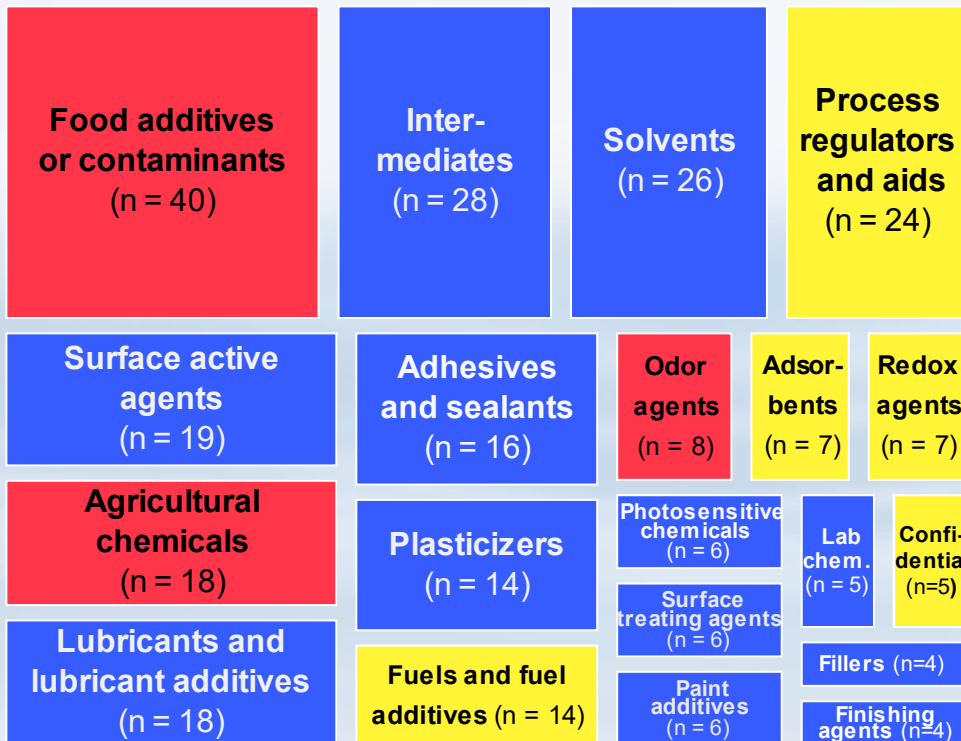
(Zimmermann, unpublished)



- 10–120 peaks per sample (max. 200)
 - 1812 compounds detected
 - 218 in NIST (score > 70)
- 12% tentatively indentifiably

(Zimmermann, unpublished)

Function of tentatively identified compounds



PeerJ Preprints

NOT PEER-REVIEWED

- 1 Chemicals associated with plastic packaging: Inventory and hazards
- 2
- 3 Ksenia J. Groh^{1*}, Thomas Backhaus², Bethanie Carney-Almroth³, Birgit Geueke¹, Pedro A. Inostroza²,
- 4 Anna Lennquist³, Maricel Maffini⁴, Heather A. Leslie⁵, Daniel Slunge⁶, Leonardo Trasande⁷, A. Michael
- 5 Warhurst⁸ and Jane Muncke¹
- 6
- 7 ¹Food Packaging Forum Foundation, Zurich, Switzerland
- 8 ²Department of Biological and Environmental Sciences, University of Gothenburg, Gothenburg, Sweden
- 9 ³International Chemical Secretariat (ChemSec), Gothenburg, Sweden
- 10 ⁴Independent Consultant, Germantown, Maryland, USA
- 11 ⁵Department of Environment & Health, Vrije Universiteit Amsterdam, The Netherlands
- 12 ⁶Centre for Sustainable Development (GMV), University of Gothenburg, Gothenburg, Sweden
- 13 ⁷School of Medicine, New York University, New York, USA
- 14 ⁸CHEM Trust, London, United Kingdom

→ 19 compounds associated with plastic packaging
→ 27 chemicals (possibly)

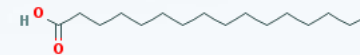
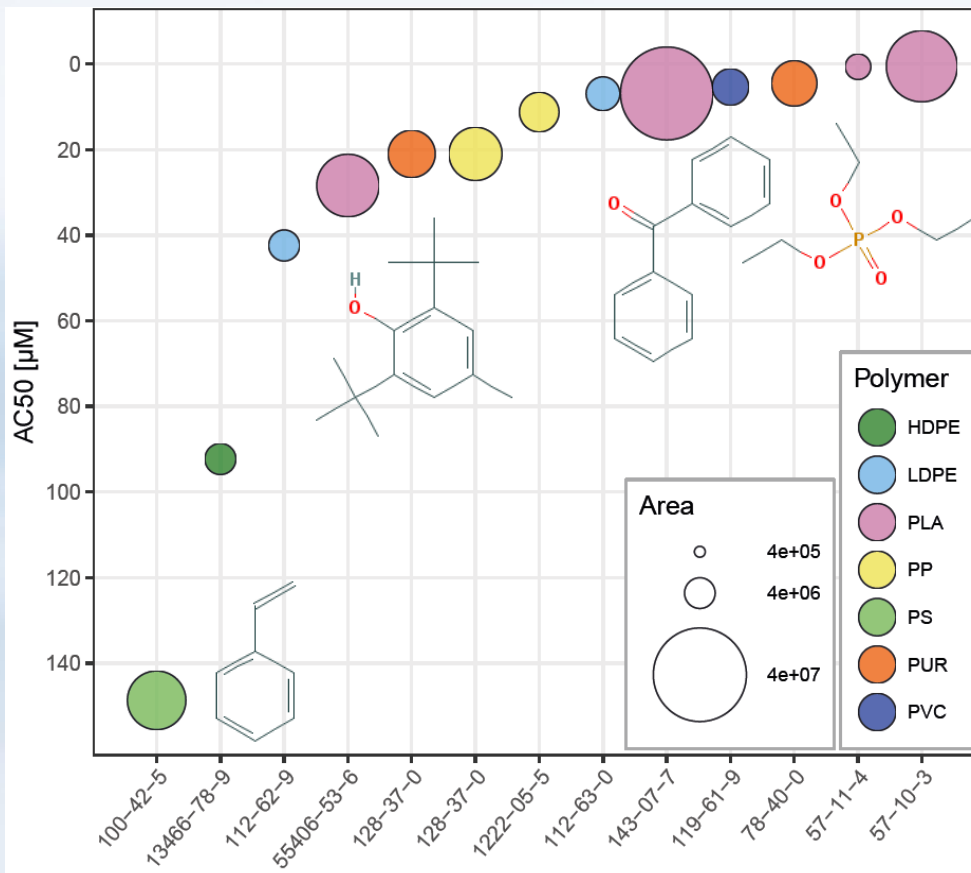
(Zimmermann, unpublished; CPPdb by Groh et al., 2018, peerJ preprint)

Prioritization of compounds

PubChem
BioAssay



ToxCast™



Palmitic acid

Stearic acid

Triethyl Phosphate

Benzophenone

Lauric Acid

Methyl Linoleate

Galaxolide

Butylated Hydroxytoluene

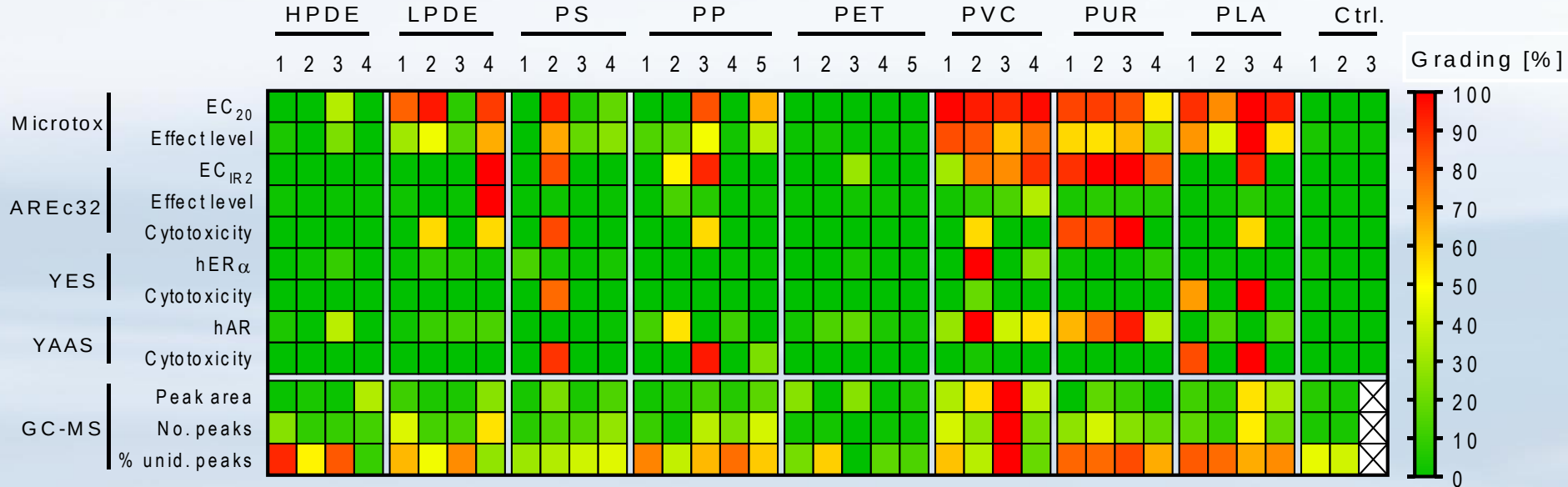
Iodopropynyl Butylcarbamate

Methyl Oleate

3-Carene

Styrene

Toxicity in plastics: Lessons learnt



(Zimmermann, unpublished)

- bioassays: toxic chemicals, incl. EDCs, present in plastics
- chemical analysis: known compounds explain fraction of toxicity
- human exposure to unknown compounds in plastics
- challenge for public health, incl. all stakeholders
- safer alternatives already on the market

