Identification and prioritization of chemicals associated with plastic packaging

Ksenia Groh
Food Packaging Forum

HCPP Project final event
Gothenburg, 12 September 2019

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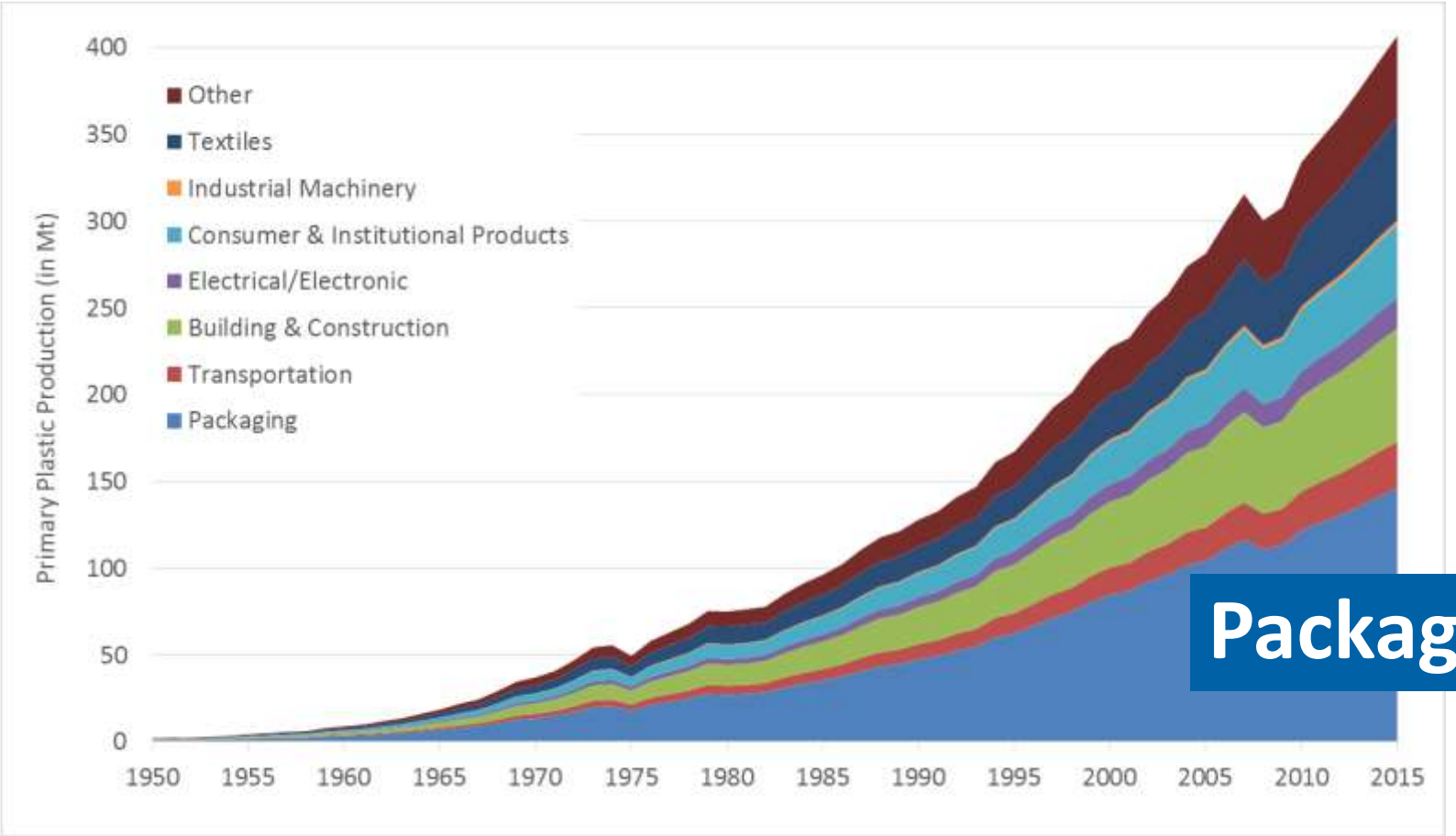
Global plastics production: 380 Mt in 2015



Packaging: ~40%

Geyer R., Jambeck J., Law K. (2017) Production, use, and fate of all plastics ever made. *Science Advances* 3(7).
http://advances.sciencemag.org/content/3/7/e1700782.full

Plastic packaging is …

- (relatively) cheap
- lightweight
- durable
- versatile, allowing for a multitude of applications

BUT

- persisting in the environment

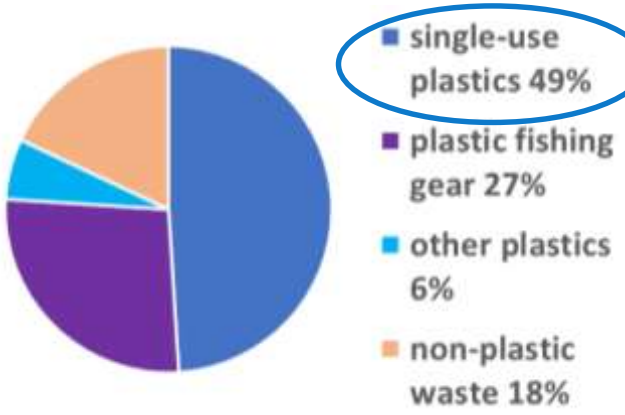
- leaching chemicals, some of which could be hazardous

High exposure potential for humans and environment

Direct contact with food

Environmental pollution

High proportion among marine litter

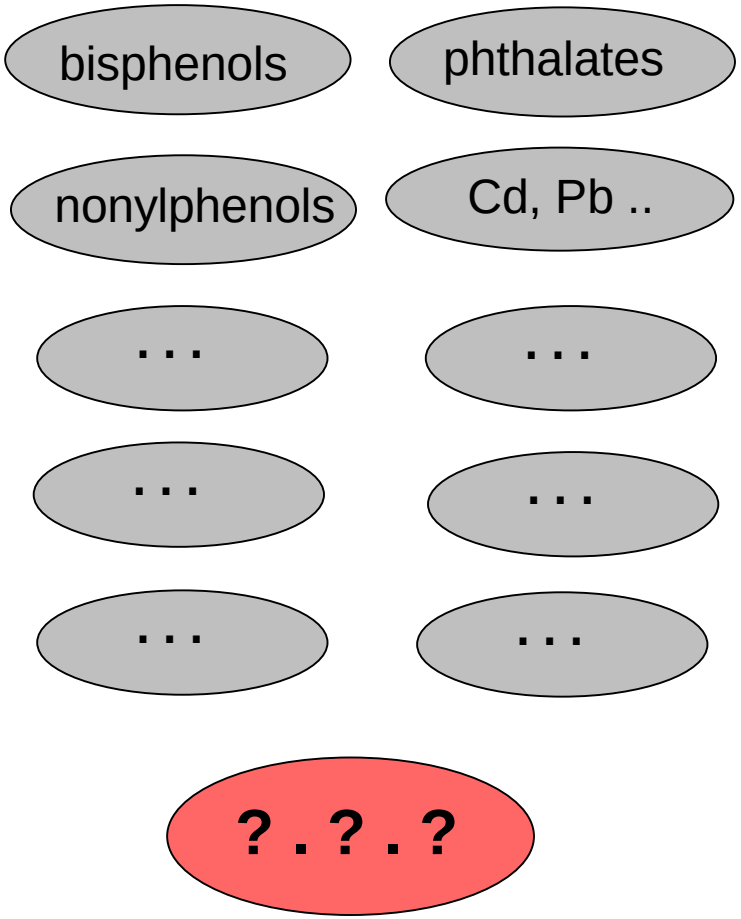


Top 10 single-use plastic items found on seashores
Drink bottles, caps, lids
Cigarette butts
Cotton bud sticks
Crisps and sweets packets and wrappers
Sanitary applications
Plastic bags
Cutlery, straws, stirrers
Drink cups, cup lids
Balloons and balloon sticks
Food containers, incl. fast food packaging

Biryol D. et al. (2017). High-throughput dietary exposure predictions for chemical migrants from food contact substances for use in chemical prioritization. *Environment International* 108: 185-194. http://dx.doi.org/10.1016/j.envint.2017.08.004

European Parliament (2018). Plastic in the ocean: the facts, effects and new EU rules. https://www.europarl.Europa.eu/news/en/headlines/society/20181005SO15110/plastic-in-the-ocean-the-facts-effects-and-new-eu-rules/

Hazardous chemicals in plastic packaging?



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Hazardous chemicals in plastic packaging: State of the art, prioritization, and assessment

- HCPP: multi-partner project led by FPF, 2017-2019

- Aims
  - raise awareness for chemicals in plastic packaging
  - identify chemicals associated with plastic packaging
  - assess their hazards and identify candidates for substitution
  - human health and environmental assessment for selected substances

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Chemical composition of plastics

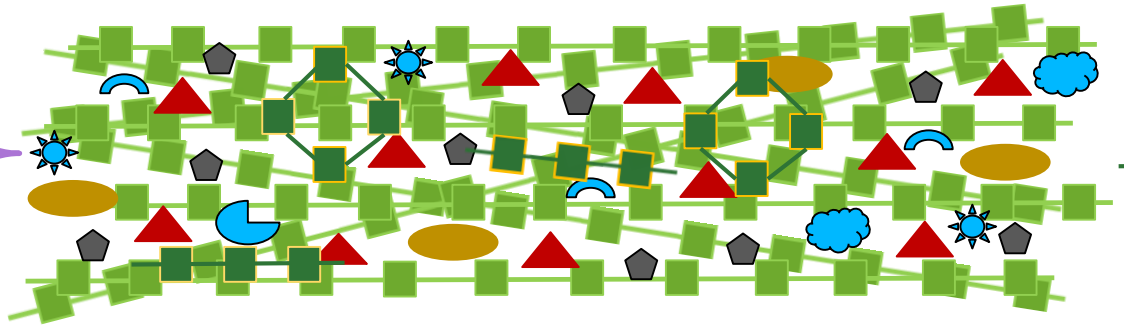
IAS:
intentionally
added substances

monomers

additives

processing aids
e.g. solvents

final compounded plastics material



NIAS:
non-intentionally
added substances

impurities and
contaminants

oligomers

reaction by-products
and side products,
breakdown products,
neoformed products

Dossier –
Non-intentionally added substances (NIAS)

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June 2018, 2nd edition DOI: 10.5281/zenodo.1265331 Birgit Geueke

Material constituents of plastic packaging

Final compounded plastic polymers, single or in combination

+ other components such as printing inks, adhesives, foils, coatings . . .

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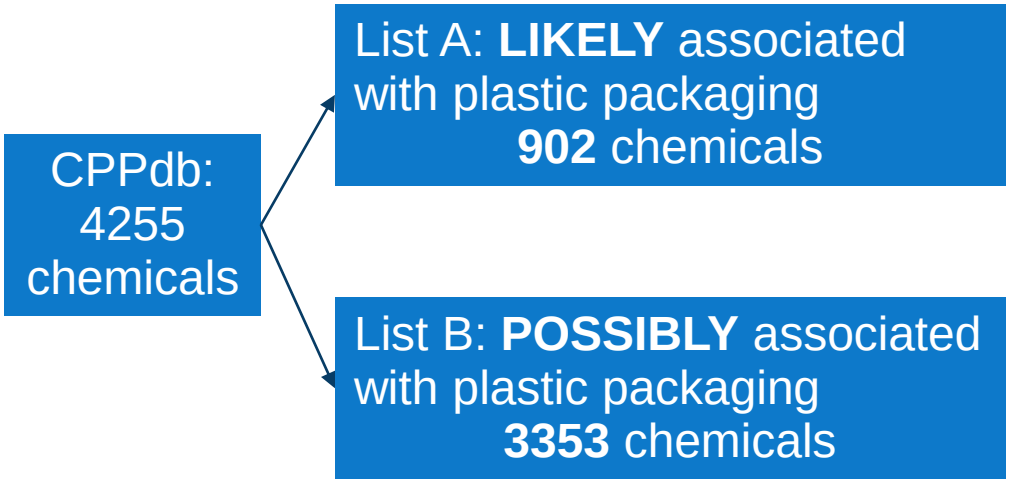
Database of Chemicals associated with Plastic Packaging (CPPdb)

- compilation of publicly available information sources
- covering both food and non-food packaging



Challenge:
insufficient transparency and lack of information on the actual use and levels of chemicals in plastic packaging

Current database version can be downloaded at https://doi.org/10.5281/zenodo.1287773

Groh K. et al. (2018) Overview of known plastic packaging-associated chemicals and their hazards. *Science of the Total Environment* 651: 3253-3268. https://doi.org/10.1016/j.scitotenv.2018.10.015

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Hazardous chemicals associated with plastic packaging

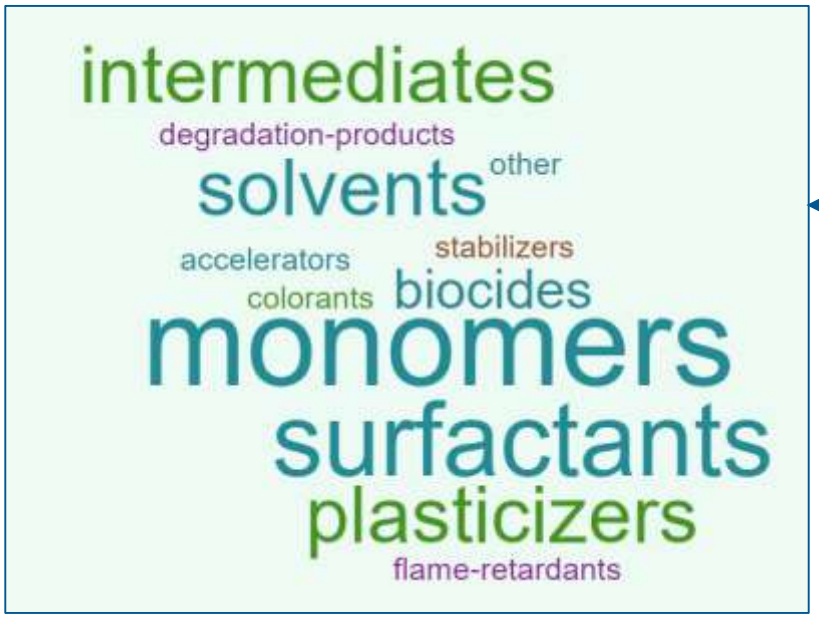
List A: **LIKELY** associated with plastic packaging
902 chemicals

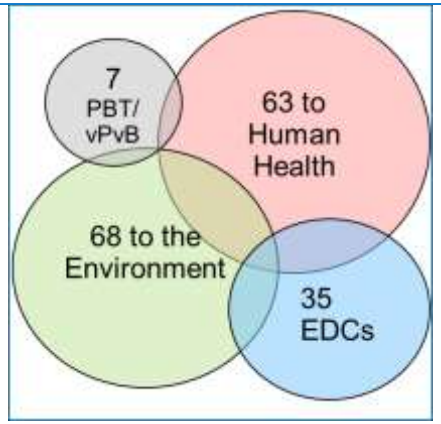
harmonized GHS-aligned hazard classifications

% chemicals with CLP classifications available:
~13% on environmental hazards
~27% on human health hazards

+ EDC identification, REACH/UNEP
+ PBT/vPvB identification, EU

List of 148 top hazardous chemicals likely associated with plastic packaging, including (with overlaps):





Groh K. et al. (2018) Overview of known plastic packaging-associated chemicals and their hazards. *Science of the Total Environment* 651: 3253-3268. https://doi.org/10.1016/j.scitotenv.2018.10.015

Food contact chemicals among CPPdb chemicals

CPPdb sublist	Total number of chemicals
ListA – likely associated with plastic food packaging	902
Top hazardous for human health based on harmonized classifications	63
Top hazardous for the environment based on harmonized classifications	68
PBT/vPvB classified (EU)	7
Conservatively identified EDCs	35

- the majority of top hazardous chemicals associated with plastic packaging have indications of food contact use

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Lack of harmonized hazard data for many CPPdb chemicals

CPPdb sublist	Total number of chemicals	Of them, chemicals used in food contact
ListA – likely associated with plastic food packaging	902	788 (87.4%)
Top hazardous for human health based on **harmonized** classifications	63	55 (87.3%)
Top hazardous for the environment based on harmonized classifications	68	45 (66.2%)
PBT/vPvB classified (EU)	7	6 (85.7%)
Conservatively identified EDCs	35	35 (100%)
Top hazardous for human health based on **advisory** classifications	102	97 (95.1%)

- many chemicals lacking harmonized hazard data could actually be hazardous as well

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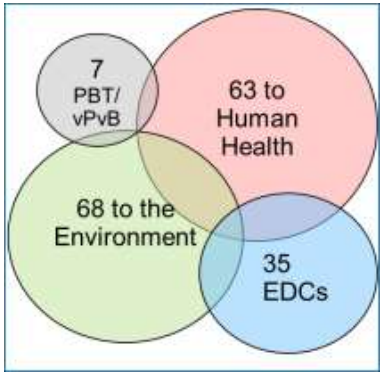
Prioritizing for substitution: Environment

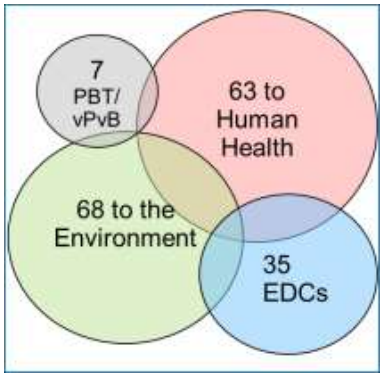


Criterium	N chemicals
Highest CLP sum hazard score (1100) for the environment	68
Any data available in ECOTOX database	54
ECOTOX data available for Standard Test Species	29
Not containing metals or metal groups	15
Use in plastic packaging confirmed by additional primary literature searches	6
Consideration of data on exposure and environment-relevant effects	1*

Substance	CAS number
Benzyl butyl phthalate (BBP)	85-68-7
Diphenylamine	122-39-4
Nonylphenol	25154-52-3
4-*tert*-Octylphenol	140-66-9
2,2',6,6'-Tetrabromobisphenol A	79-94-7
Triclosan	3380-34-5

Geueke B. et al. (2018) Prioritization approaches for hazardous chemicals associated with plastic packaging. *Food Packaging Forum* https://doi.org/10.5281/zenodo.14364425

Prioritizing for substitution
Human Health



Criterium	N chemicals
Highest CLP sum hazard score (>10,000) for human health	63
NHANES biomonitoring data available (indication of human exposure)	16
Consideration of regulatory status under REACH and endocrine disrupting properties for human health	5*

Name	CAS No	CLP hazard score for human health
Benzyl butyl phthalate (BBP)	85-68-7	10000
Bis(2-ethylhexyl) phthalate (DEHP)	117-81-7	10000
Dibutyl phthalate (DBP)	84-74-2	10000
Diisobutyl phthalate (DiBP)	84-69-5	10000
Dicyclohexyl phthalate (DCHP)	84-61-7	11000

Geueke B. et al. (2018) Prioritization approaches for hazardous chemicals associated with plastic packaging. *Food Packaging Forum* https://doi.org/10.5281/zenodo.14364425

Take-home messages

- Numerous hazardous chemicals associated with plastic packaging
- (Harmonized) hazard data missing for many more substances
- High complexity and lack of transparency hinder comprehensive overview and risk assessment
- Phthalates highlighted as candidates for substitution.
  Are there other important chemicals we should be looking at?
- Non-intentionally added substances pose unique challenges for systematic identification, toxicity testing, risk assessment

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Hazardous Chemicals in Plastic Packaging (HCPP)

Funding: MAVA foundation

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Michel Dedeo
Tom Lent
Bill Walsh
Healthy Buildings Network

Thank you for your attention!

www.foodpackagingforum.org

Save the date: 24 October 2019

Improving the chemical safety of food contact articles:

accelerating science and innovation

7th FPF workshop, Zurich, Switzerland

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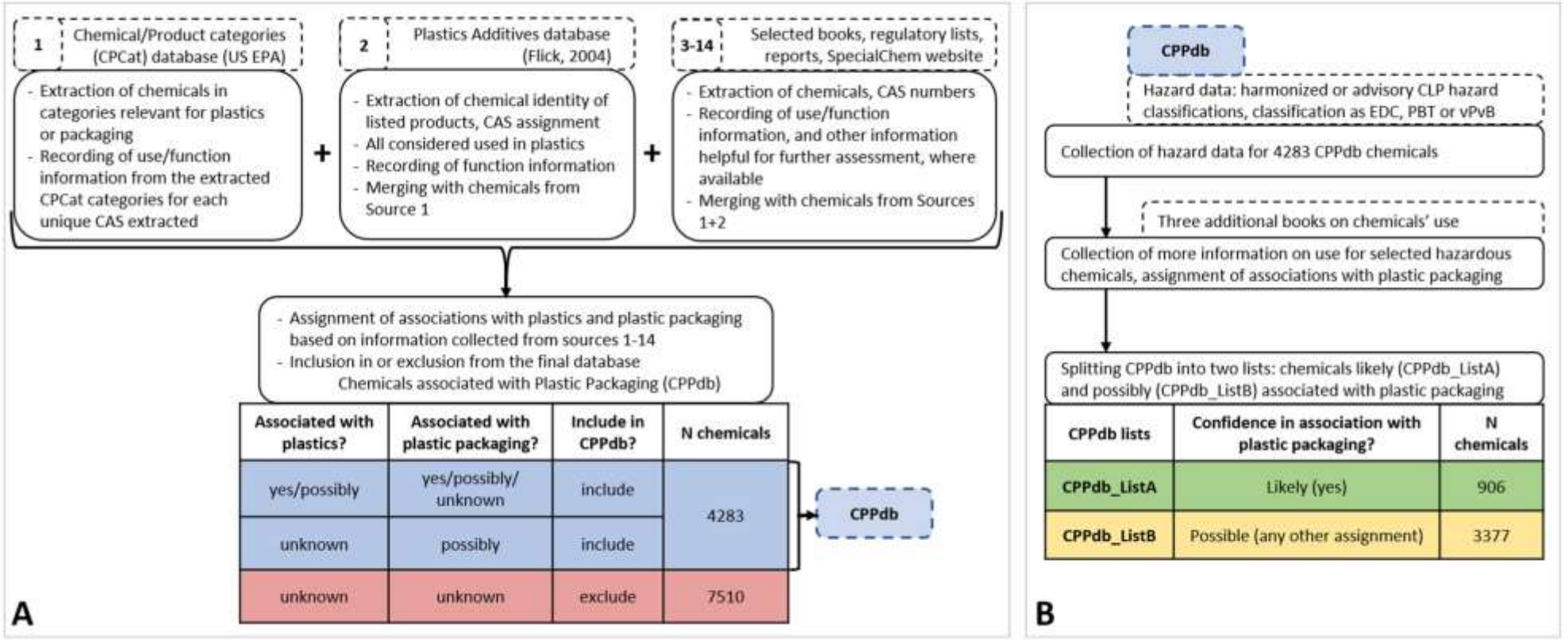
Compilation of CPPdb



Overview of information sources (dashed-line boxes) and approaches/workflow (solid-line boxes) followed to
(A) compile the database of chemicals associated with plastic packaging (CPPdb) and
(B) split the full CPPdb into the two lists according to the assigned likely (CPPdb_ListA) or possible (CPPdb_ListB) association with plastic packaging.

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Comparison to ECHA's database of plastic additives

ECHA (2019) Mapping exercise – Plastic additives initiative
https://echa.europa.eu/mapping-exercise-plastic-additives-initiative

Function as identified by ECHA	N substances listed by ECHA	N substances (% of total in this category)		
		on CPPdb_ListA	on CPPdb_ListB	not listed in CPPdb
Antioxidants	25	18 (72%)	5 (20%)	2 (8%)
Antistatic agents	15	9 (60%)	2 (13%)	4 (27%)
Flame retardants	36	9 (25%)	17 (47%)	10 (28%)
Heat stabilizers	27	12 (44%)	11 (41%)	4 (15%)
Light stabilizers	15	6 (40%)	7 (47%)	2 (13%)
Other stabilizers	20	6 (30%)	10 (50%)	4 (20%)
Other functions*	72	16 (22%)	17 (24%)	39 (54%)
Pigments agents	126	57 (45%)	38 (30%)	31 (25%)
Plasticizers	56	26 (46%)	11 (20%)	19 (34%)
All identified **	392	159 (41%)	118 (30%)	115 (29%)

*including nucleating agents
**based on CAS availability

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Food Packaging Forum (FPF) foundation

- Science communication and research
- Food contact materials/chemicals, migration, health effects
- Founded in 2012 in Zürich
- Non-profit, funded by unconditional donations
- For scientists, industry and policy experts, communicators

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SCIENTIFIC PUBLICATIONS

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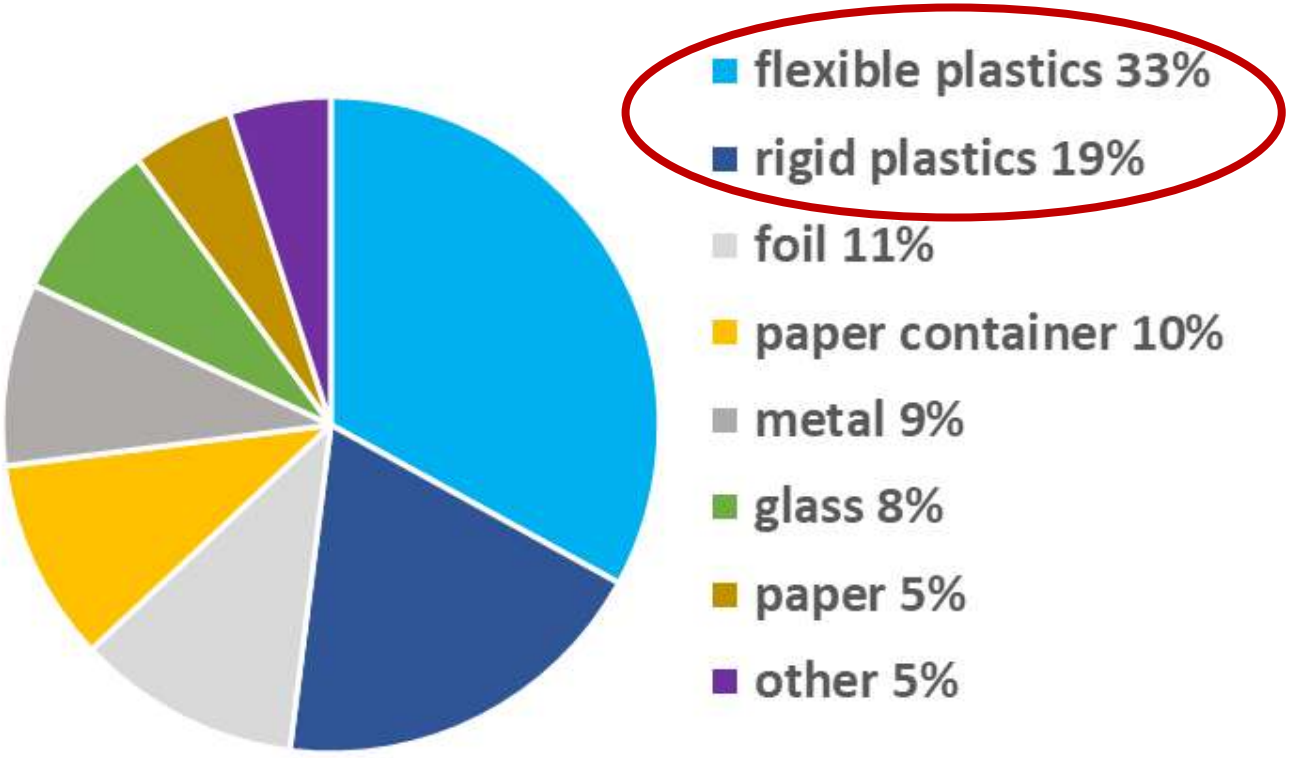
Plastics' share among food packaging materials



CiTi GPS (2018). Rethinking single-use plastics. August 2018.
https://privateclientsolutions.citi.com/insights/citi-gps-rethinking-single-use-plastics/

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Plastics recycling: Chemical safety aspects

Journal of Cleaner Production 193 (2018) 491–505

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Review

Food packaging in the circular economy: Overview of chemical safety aspects for commonly used materials

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ABSTRACT

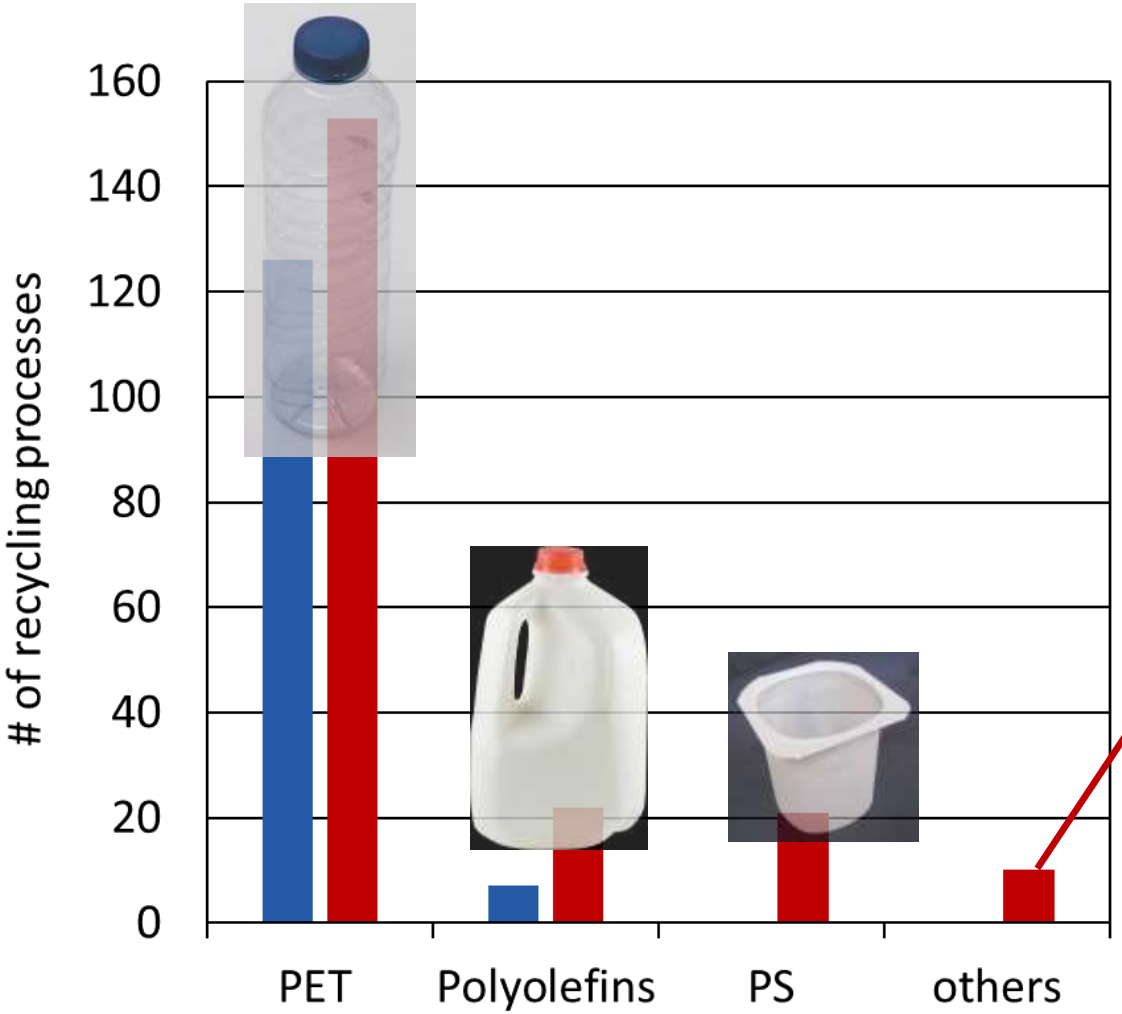
Food packaging facilitates storage, handling, transport, and preservation of food and is essential for preventing food waste. Besides these beneficial properties, food packaging causes rising concern for the environment due to its high production volume, often short usage time, and problems related to waste management and littering. Reduction, reuse, and recycling, but also redesign support the aims of the circular economy. These tools also have the potential to decrease the environmental impact of food packaging.

In this article, we focus on chemical safety aspects of recycled food packaging, as recycling is currently seen as an important measure to manage packaging waste. However, recycling may increase the levels of

https://doi.org/10.1016/j.jclepro.2018.05.005

- Metals and glass are **'permanent'** materials with theoretically unlimited recycling
- Plastics and paper are **'non-permanent'** materials that degrade during (mechanical) recycling, thus requiring addition of virgin material during each recycling round

Mechanical recycling processes for plastic FCMs



Favorable opinions on plastics recycling published by EFSA and the US FDA (March 2018)

Geueke B. et al. (2018) Food packaging in the circular economy: Overview of chemical safety aspects for commonly used materials. *Journal of Cleaner Production* 193: 491-505. https://doi.org/10.1016/j.jclepro.2018.05.005

Geueke B. (2014) Plastic recycling. *Food Packaging Forum.* Dossier. https://doi.org/10.5281/zenodo.33521

Typical contaminants in recycled plastics

	Possible origin	Examples
Flavor, aroma, odor compounds	Previous food and non-food applications	Limonene, p-cymene
Oligomers, monomers and derivatives	Production of virgin materials; degradation during use and recycling	Linear and cyclic oligomers, acetophenone, benzaldehyde
Additives and their degradation products	Production of virgin materials; degradation during use and recycling; cross-contaminations	UV absorbers, antioxidants, plasticizers, other additives
Contamination by non-food grade hazardous substances	Mixed collection of non-food grade plastics; adulteration; consumer misuse	Brominated flame retardants, dioxin-like compounds, sulfuric compounds
Inorganic elements	Catalysts; environmental origin; recycling infrastructure	Heavy metals

- need to ensure that recycling does not compromise FCM's safety