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Safety assessment of recycled flexible plastic for application in food or cosmetic packaging

Mitglied bei:
ACR
AUSTRIAN COOPERATIVE RESEARCH

OFI – Austrian Research Institute for Chemistry and Technology

Independent, accredited and certified Austrian research and testing institute with a focus on material application and structural engineering

OFI in numbers

1946 Established as private research and testing institute

110 employees

3 locations in Austria
Vienna (2x), Klagenfurt

~ 14 Mio. EUR turnover (2021)

~ 1.200 customers

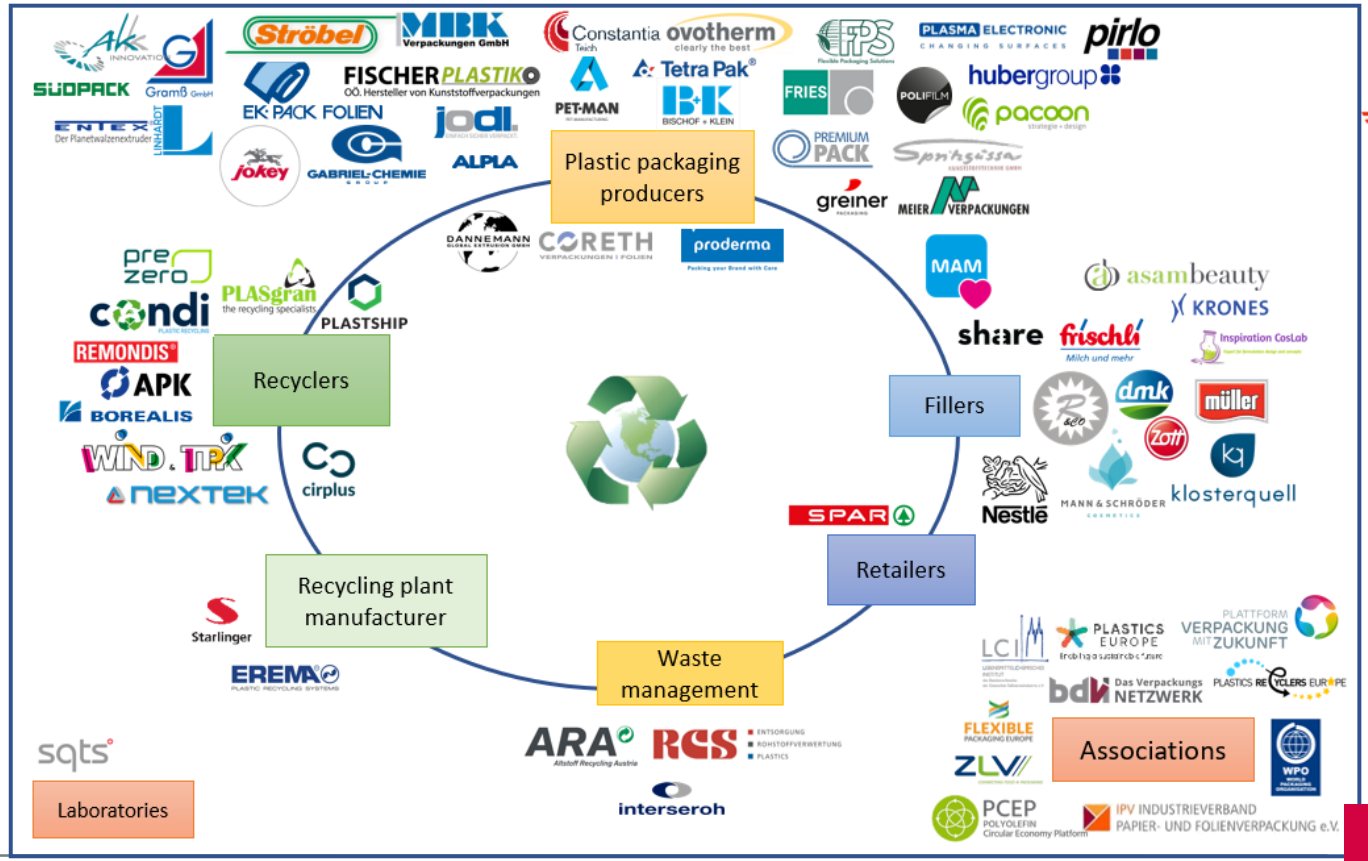
~ 700 accredited testing and certification methods

Project Safe Cycle

Research Institutes

Fraunhofer IVV

FH CAMPUS WIEN UNIVERSITY OF APPLIED SCIENCES



KC KUNSTSTOFF CLUSTER

plus eco

cluster niederösterreich

Potential health risk by contaminants prevents recycling!

Recycling back to Food Packaging Material: **only possible for PET bottles!**

EFSA Evaluation based on absolute Worst-Case Assumption

Table 2: TTC values – classification of substances

Classification	Worst Case Assumption	TTC value in µg/person per day
Potential DNA-reactive mutagens and/or carcinogens		0.15
Organophosphates and carbamates		18
Cramer Class III		90
Cramer Class II		540
Cramer Class I		1,800

EFSA Scientific Committee. (2019). Guidance on the use of the Threshold of Toxicological Concern approach in food safety assessment. EFSA Journal, 17(6), e05708.

Possible contaminations in recycled materials

Contaminants during recycling, sorting & cleaning

Compo… …from food into packag…

Flavour c… …ostances from food, food additiv…

Ad… …rade plastic

Additives of nor… …tic

Degradation products during recycling

Contami… …ended use

(e.g. pestici…

Original NIAS of recycled plastic

TTC concept – Risk assessment

Current EFSA Assumption:

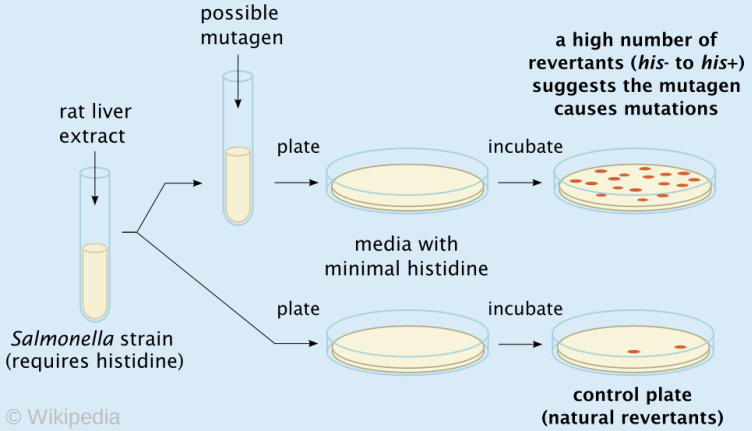
- All input material for recycling is contaminated with DNA-reactive carcinogens!
- None of the evaluated Polyolefin Recycling Processes is sufficient to prevent critical levels of DNA-reactive carcinogens

Cramer Class I	1,800

EFSA Scientific Committee. (2019). Guidance on the use of the Threshold of Toxicological Concern approach in food safety assessment. EFSA Journal, 17(6), e05708.

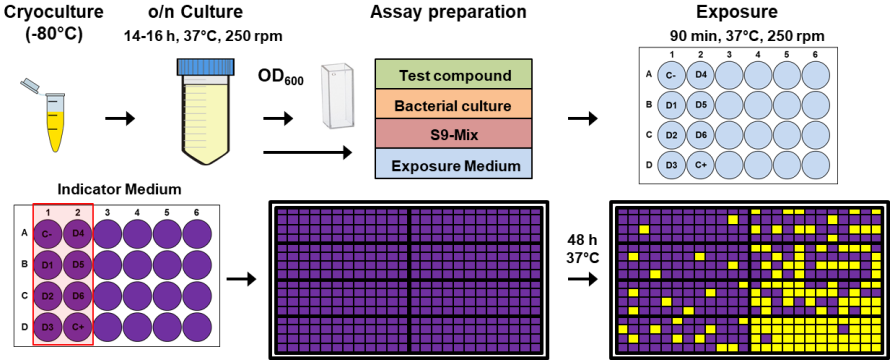
Ames Assay: detects direct DNA-reactive substances

Ames Test



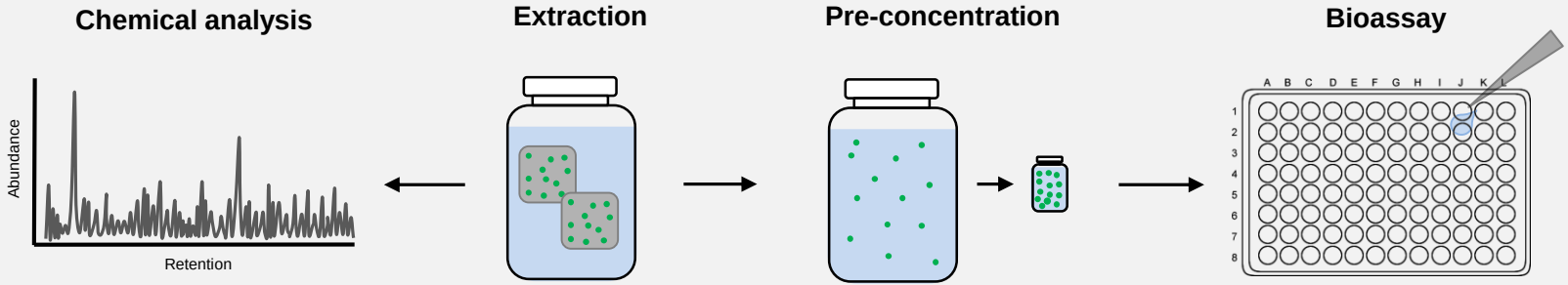
+ Sensitive and robust
+ Broad acceptance (OECD Guidelines)
+ Focus on direct DNA-reactive substances
- Labour intensive
- Space consuming

Miniaturized Ames Test (Ames MPF)

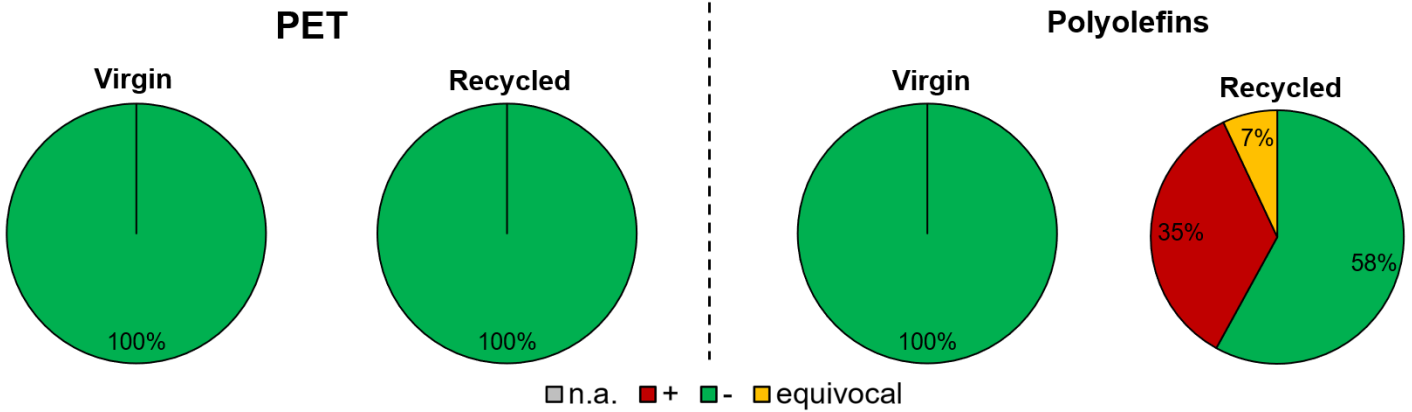


- Cultivation and exposure in liquid medium
- Colorimetric readout
- Higher throughput (microtiter plates)
+ Lower sample amounts required
+ Less incubator space required

> 100 recycled plastic samples analysed!

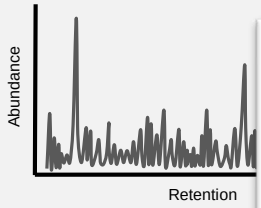


Recycled Plastics



> 100 recycled plastic samples analysed!

Chemical analysis | **Extraction** | **Pre-concentration** | **Bioassay**



Open Access | Article

Safety Assessment of Recycled Plastics from Post-Consumer Waste with a Combination of a Miniaturized Ames Test and Chromatographic Analysis

by Elisa Mayrhofer [1,*,†], Lukas Prielinger [2,†], Victor Sharp [1], Bernhard Rainer [2], Christian Kirchnawy [1], Christian Rung [3], Anita Gruner [3], Mladen Juric [3] and Arielle Springer [3,*]

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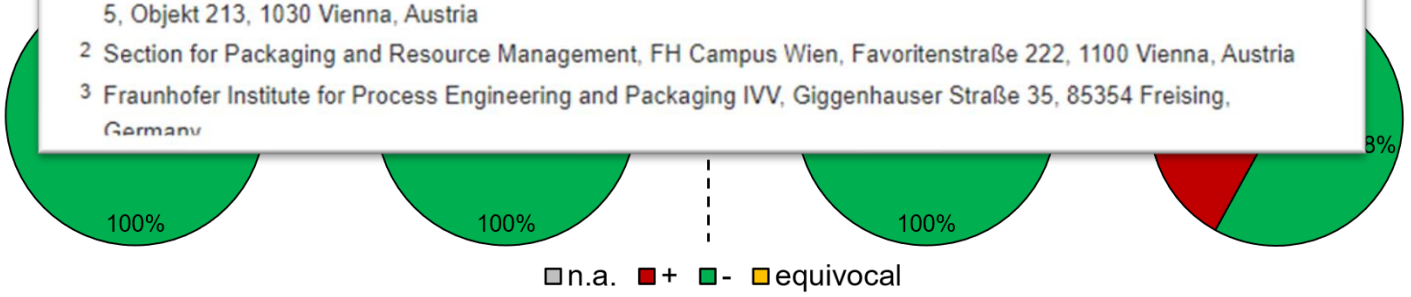
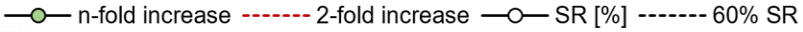
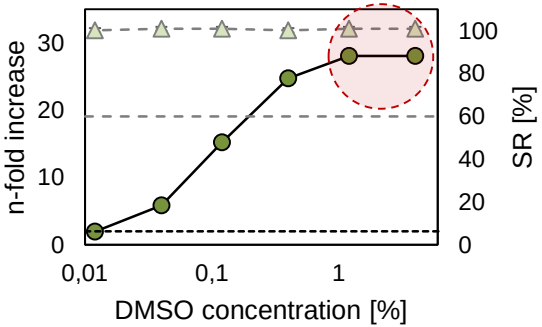
Recycled Plastics



Some polyolefin recyclates score strongly positive!

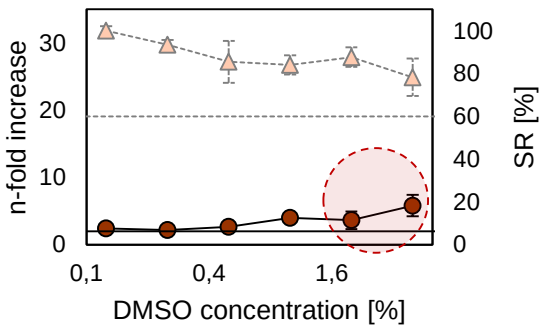


Recycled polyolefin



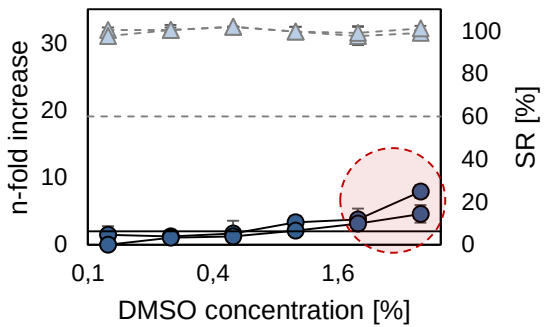
VS

Mutagenic reference oil (positive control)



VS

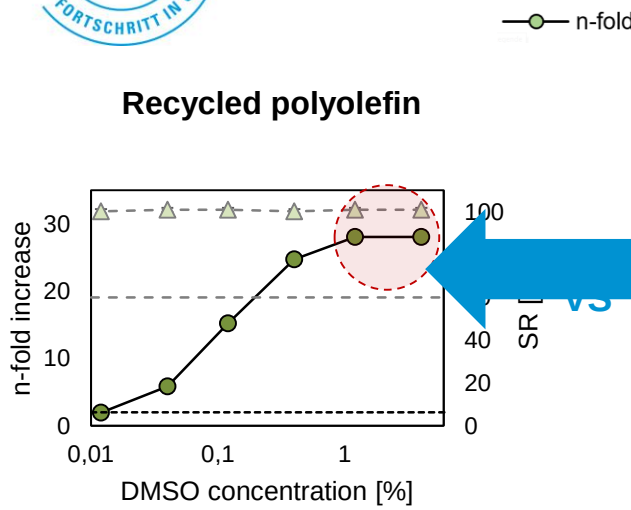
Mutagenic reference sample (for inter-lab study)



Some recycled polyolefins have strong positive effects in the Ames test, partially even higher than in mutagenic reference oils or intentionally spiked FCM samples.

However: Recycled PET scores negative in the Ames test.

Some polyolefin recyclates score strongly positive!



High mutagenic activities could only be explained by alarmlingly high concentrations of known mutagens such as primary aromatic amines or nitrosamines.

Mutagenic activity refers to the activity of a Primary Aromatic Amines or Nitrosamines in concentration of > 100 mg/L!

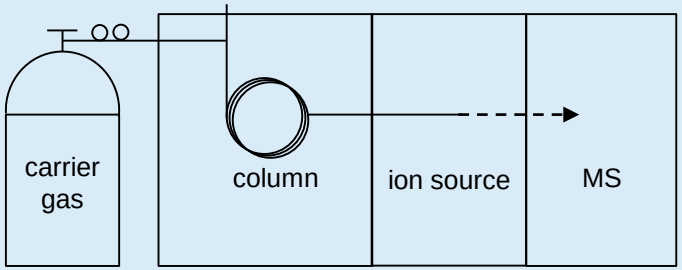
Some recycled polyolefins have strong positive effects in the Ames test, partially even higher than in mutagenic reference oils or intentionally spiked FCM samples.

However: Recycled PET scores negative in the Ames test.

DNA-reactive substances not detectable by GC-MS Screenings

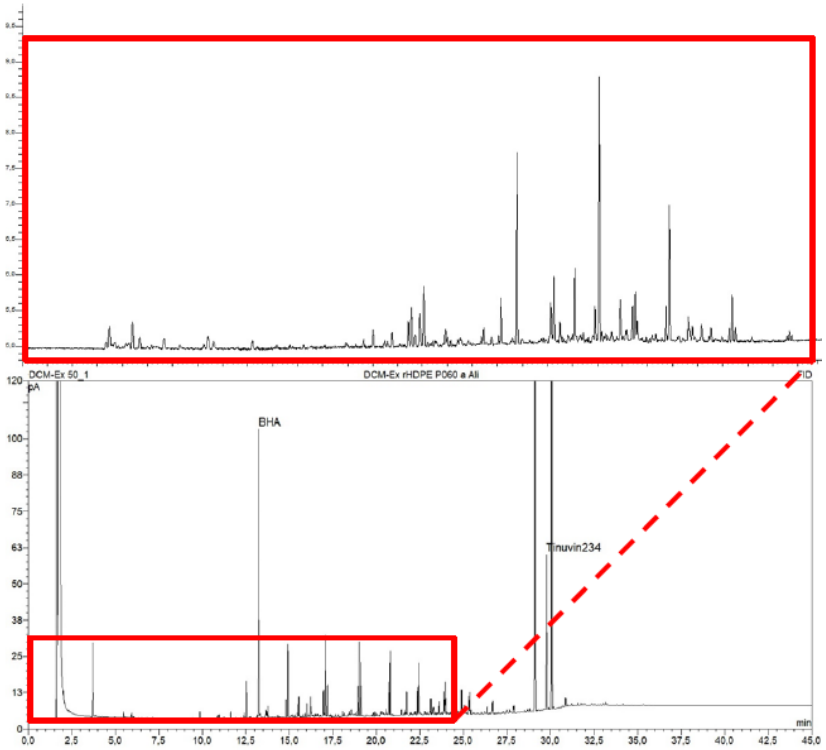
Standard screening

Non-target GC-MS screening

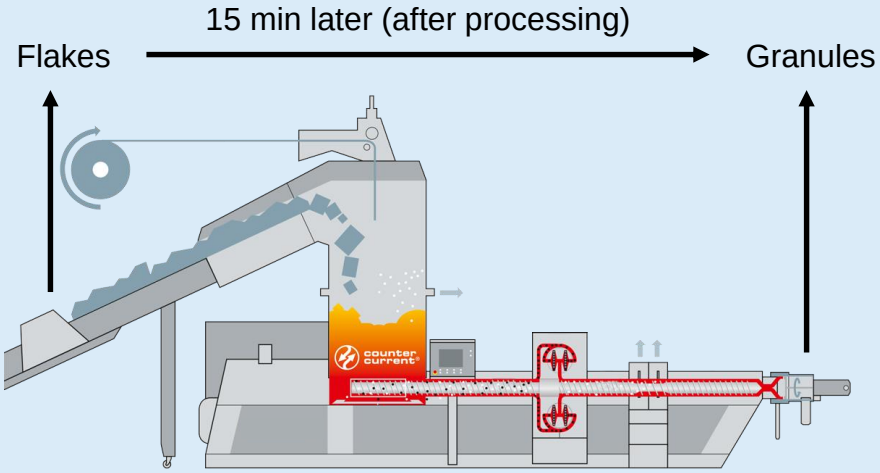


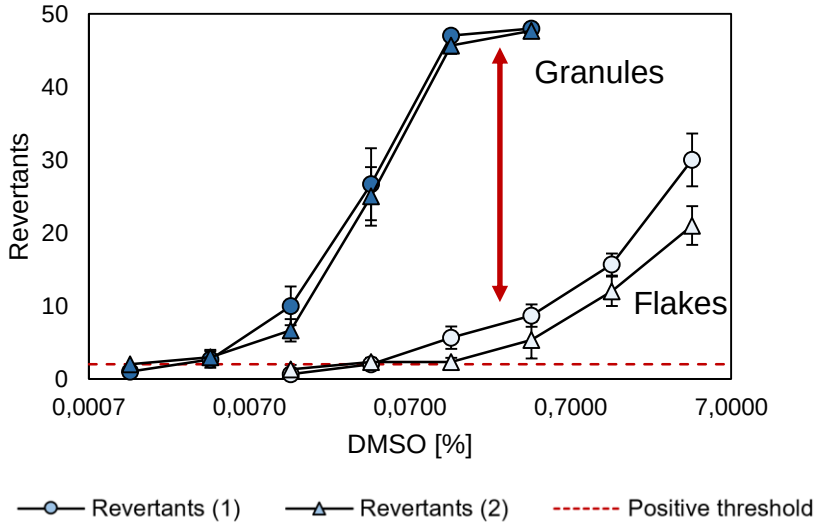
DNA-reactive substances not detectable by standard GC-MS non-target screenings!

Primary Aromatic Amines detected in Target Screenings



Signal intensity increases during processing





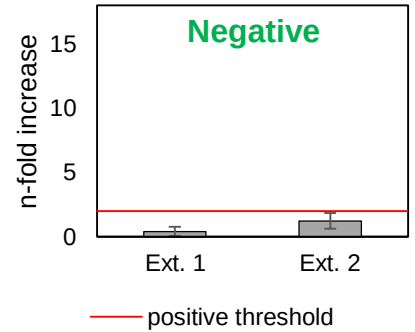
Granules show higher mutagenicity signals than corresponding flakes. This indicates that Ames positives substances might be mainly formed during treatment steps in the extruder.

Degradation products of printing inks as a risk factor for recycling

Only printed AND recycled materials scored Ames positive!

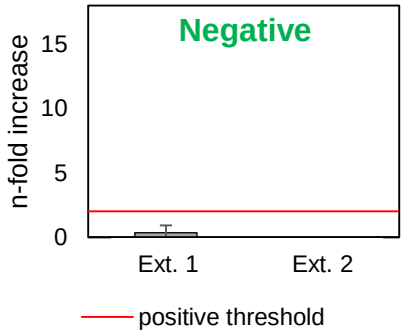
Unprinted foil

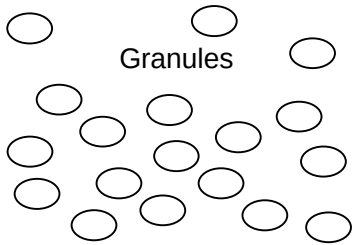
Printed foil

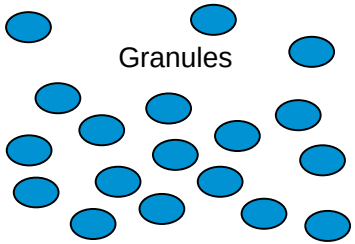


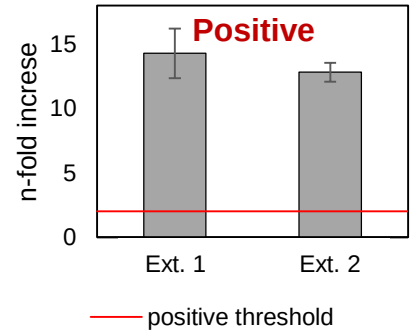
Recycling process

Recycling process

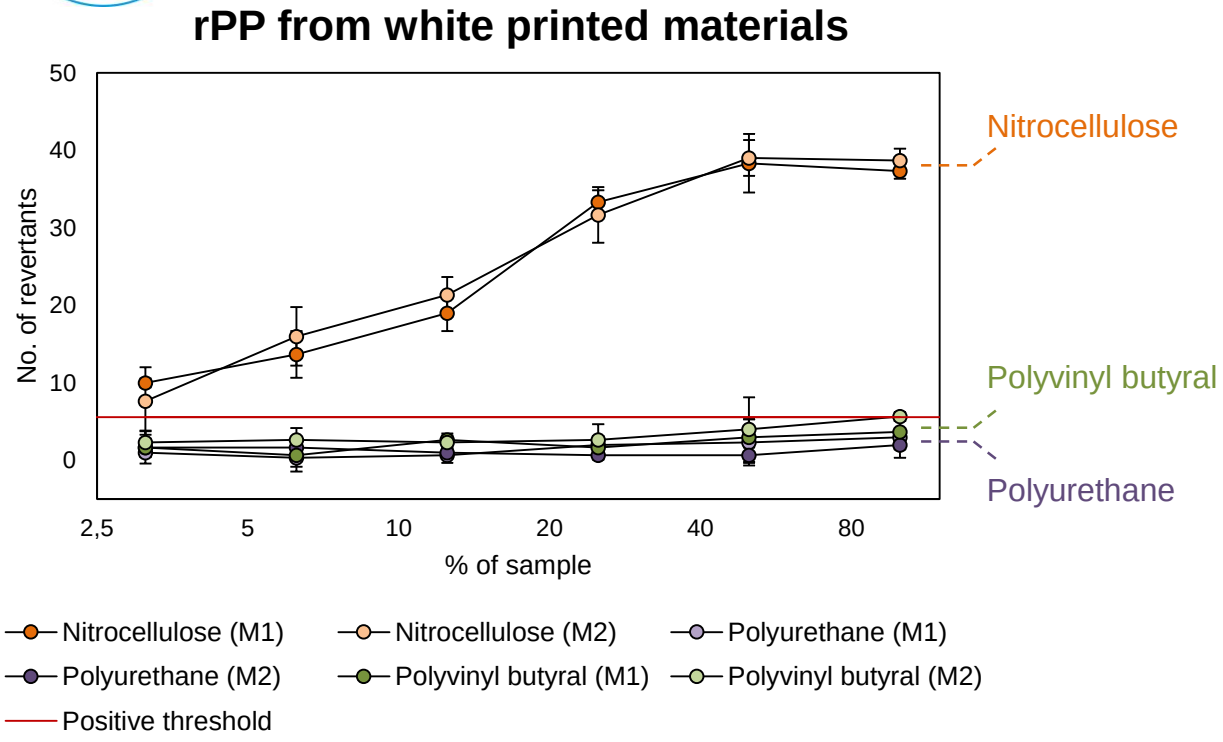








Nitrocellulose Binders for Inks indentified as a risk factor!



rPP recyclates were produced from white printed input streams.

Printing inks based on:

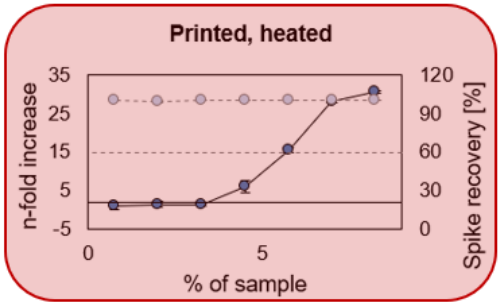
- Nitrocellulose (NC)
- Polyvinyl butyral (PVB)
- Polyurethane (PU)

Recyclates from nitrocellulose-based printed samples are strongly Ames positive.

Nitrocellulose based Inks are not the only challenge for recycling

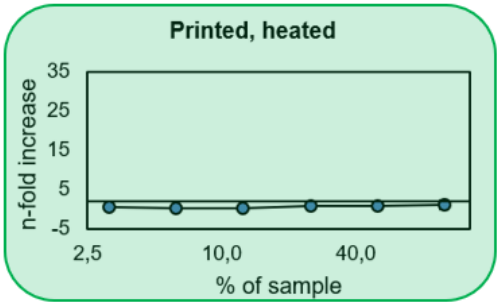
Recycled Polyurethane based Inks: No systematic mutagenic activity
BUT: mutagenic activity in some recycled multicolor PU based inks.

Multicolor PU-printing ink, recycled



VS

White PU-printing ink, recycled



Nitrocellulose is not the only risk factor!
More research required to closer identify other risk factors (pigments?)

Summary & Outlook

- DNA-reactive substances have 120-fold lower safety threshold than any other substance group - EFSA authorization depends on the residual DNA-reactive substances in recyclate!
- Systematic introduction of DNA-reactive contaminants in some recycled flexible packaging
- Recycling of nitrocellulose-based printing inks correlated with the formation of DNA-reactivity.
- Nitrocellulose is not the only risk factor for recycling of printed packaging
  - Other printing ink types can also lead to mutagenic activity after recycling – but less systematic (connection to specific pigments/color shades?)

No DNA-reactive contaminants detected in food-grade recycled plastic (PET)!

- Efficient De-Inking Processes or a “Design-for-Recycling” for Inks in FCM could help to improve the safety of recycled printed packaging

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