RECYCLED PAPER DISTINCTLY CONTRIBUTES TO THE BISPHENOL A, NONYLPHENOL ETHOXYLATE, AND NONYLPHENOL LOAD OF MUNICIPAL WASTEWATER

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Abstract

Bisphenol A (BPA) is used in the production of thermal paper, alkylphenol polyethoxylates are utilised in wastepaper processing. Concentrations of BPA and four alkylphenolic compounds in toilet paper, wastepaper, and cellulose have been investigated. BPA, 4-nonylphenol (NP), NP diethoxylate (NP2EO), NP monoethoxylate (NP1EO), and 4-*tert*-octylphenol (OP) were determined in all toilet paper samples at concentrations of n.d. – 430 mg/kg dry mass (dm). In cellulose, the concentrations were below or hardly above the respective limit of quantification. The BPA concentrations in wastepaper amounted to 0.093 to 4.23 mg/kg DM. Toilet paper, thus, was shown being an important source of xenoestrogen emissions to wastewater. Because of distinct contamination with xenoestrogens, both paper waste and recycled paper products should not be mixed with biological waste e.g. for co-fermentation or co-composting in order to derive organic fertilisers. The xenoestrogen contamination of toilet paper has to be reduced.

Introduction

- Endocrine disruption has become one of the most important environmental issues. One important class of hormonally active agents (HAA), also called endocrine disrupting compounds (EDC), are substances that mimic female sexual hormones (estrogens).
- Environmental occurrence and behaviour of selected natural and xenobiotic estrogens are studied at the Dresden University of Technology.
- BPA is used as an antioxidant in the colour-developing layer of thermal papers. APnEO are used as surfactants for cleaning of wastepaper pulp.

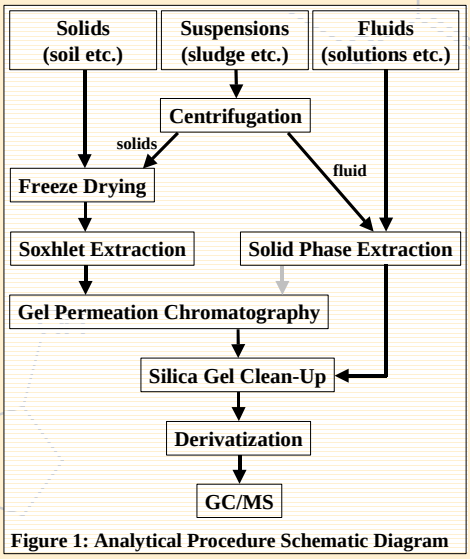

Figure 1: Analytical Procedure Schematic Diagram

Materials and Methods

- 3 sorts of toilet paper (TP), 7 classes of wastepaper (WP), 3 sorts of cellulose (C) (Gehring et al., in press)
- Gel permeation chromatography (GPC) not included in sample preparation (fig.1) except TP samples
- BPA, OP, NP, and, in part, NP1EO, and NP2EO determined in this study
- OP, NP, NP1EO, NP2EO quantified in relation to 4-*n*-NP, BPA in relation to BPA-d_{16}
- LOQ 0.2 – 38.3 µg/kg dm
- For detailed description see Weltin et al. (in press).

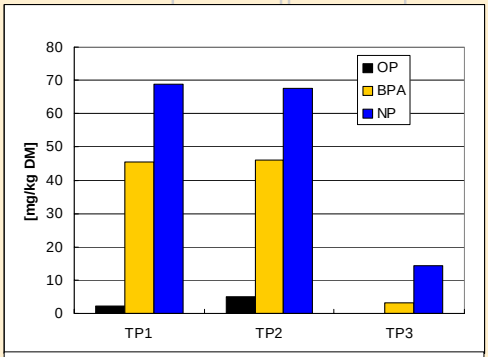

Figure 2: EDC concentrations in 3 sorts of toilet paper (100 % recycled paper)

Results – Wastepaper

- BPA: 0.093 – 4.23 mg/kg DM
- OP: 0.03 – 0.09 mg/kg DM
- NP: 0.40 – 1.01 mg/kg DM
- No correlation (fig. 3)

Results – Cellulose

- BPA: n.q.; OP: n.d.
- NP, NP1EO, NP2EO in 1 type of cellulose hardly above LOQ: 35.7 – 164.3 µg/kg dm
- BPA: n.q.; OP: n.d.

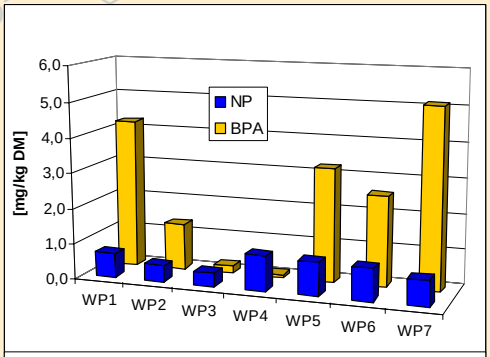

Figure 3: EDC concentrations in 7 classes of wastepaper, Germany

WP1: brown and grey corrugated board; WP2: advertising supplements; WP3: magazines; WP4: catalogues; WP5: newspapers; WP6: free advertising papers; WP7: chromo board

Results – Toilet Paper

- Poor recovery of surrogate standards (<6%) GPC subsequently excluded
- OP: n.d. – 5.1 mg/kg dm (fig. 2)
- NP: 14 – 69 mg/kg dm (fig. 2)
- BPA: 3.2 – 46 mg/kg dm (fig. 2)
- NP1EO: 10 – 31 mg/kg dm
- NP2EO: 57 – 430 mg/kg dm
- OP, NP, and BPA concentrations in TP1 and TP2 exceeded those in TP3 by factor of up to 15.

Discussion

- Occurrence of alkylphenolic compounds in WP in accordance with literature (e.g., Bennie, 1999) but unexpected high concentrations
- BPA concentrations in WP correspond to respective proportion of WP reused for paper production
- BPA concentrations in TP according to Vingaard et al. (2000): 6.21 mg/kg (mean; n = 9) in tissue kitchen rolls

Conclusions

- TP is a major EDC emission source. EDC load derives from WP/WP processing.
- Thermal paper production introduces BPA to paper cycle.
- Recycled paper products should not be mixed with biological waste for organic fertiliser production.

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