Alkylphenols from drinking water and food consumption: an integrated human health risk assessment

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Introduction

The anthropic water cycle promotes the cross-contamination of different environmental compartments by contaminants of emerging concern (CECs) (Fig. 1).
The present work is aimed at developing an integrated framework for the quantitative chemical risk assessment (QCRA) due to multiple exposures to CECs from the consumption of both drinking water (DW) and food from edible crops. Two alkylphenols, bisphenol A (BPA) and nonylphenol (NP), were considered as reference CECs.

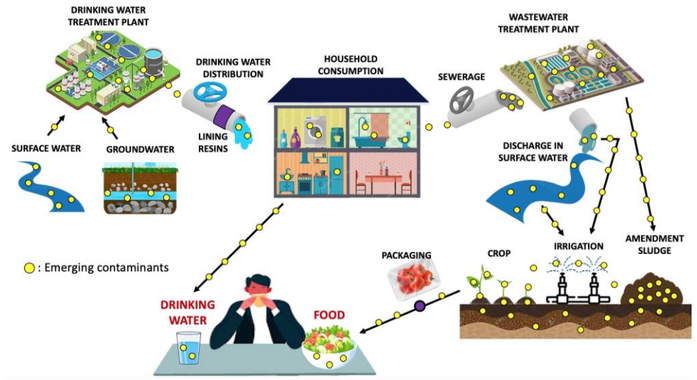

Figure 1. Schematic overview of the anthropic water cycle.

Methodology

The developed procedure includes several steps. Firstly, in the exposure assessment step, the relevant compartments regulating alkylphenols' fate from source to the end-user are identified. Then, exposure models are fed with literature data. In the hazard assessment step, compounds' adverse effects on the affected critical endpoints are determined by defining a Reference Dose (RfD). Notably, for BPA, a RfD equal to 0.04 $ng_{BPA}\ kg^{-1}{}_{bw}$ is used, according to a draft scientific opinion published by the European Food Safety Authority (EFSA) in 2022, in which BPA critical endpoint was re-evaluated from the renal system to the immune system (*EFSA, 2022*). Finally, exposure and hazard assessment steps are combined to quantitatively estimate human health risk for alkylphenols as Benchmark Quotient (BQ) (*Cantoni et al., 2021*), including uncertainty analyses to account for knowledge gaps.

Results

Looking at the concentrations of BPA (290 concentration values collected from 62 articles) and NP (183 concentration values collected from 35 articles) in the compartments of concern (Fig. 2) is it possible to point out that:

- literature data variability for alkylphenols concentration is markedly high;
- alkylphenols concentration ranges are significantly diverse among different compartments and vary between 10^{-4} and 10^{1} µg L^{-1} in DW and between 10^{-1} and 10^{3} µg kg^{-1} in food.

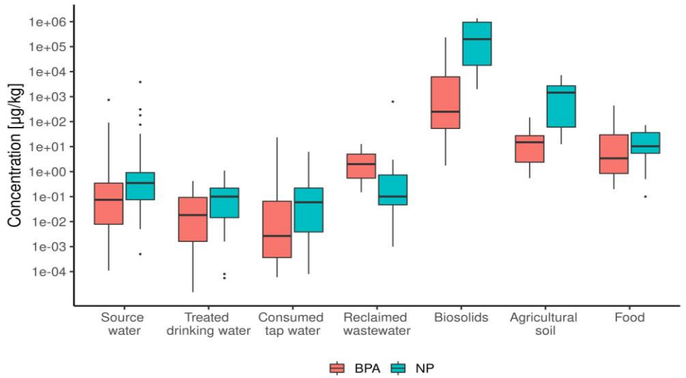

Figure 2. BPA and NP concentration ranges in the compartments of concern.

Then, the health risk, as BQ, due to the consumption of DW and food was estimated (Fig. 3), indicating that:

- both DW and food consumption exposure pathways can be critical for human health risk, in particular, due to BPA;
- BPA, whose BQ is much higher than the NP's one, and greater than 1 as well, is identified as the contaminant most affecting the human health risk, especially due to its concentration in food.

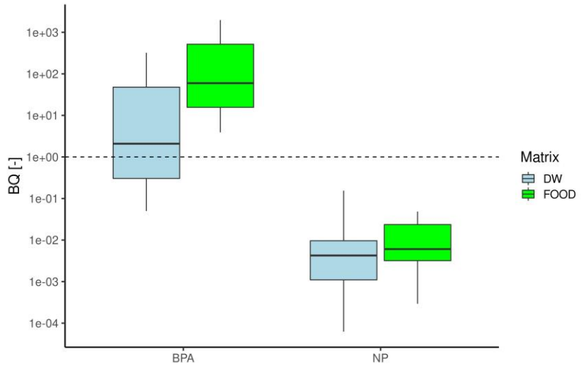

Figure 3. BPA and NP human health risk distributions, expressed as BQ, differentiated per drinking water (DW) and food from edible crops (FOOD).

Conclusions

This work highlights how human health risk assessment, when performed inside a comprehensive boundary, allows to:

- prioritize contaminants and/or risk sources;
- suggest where more research efforts are needed to fill knowledge gaps, evident in unexplained data variability, which results in high uncertainty in the estimated risk;
- support the planning of most appropriate interventions to effectively reduce the risk for consumers, but only once a reasonable confidence in the major source of contamination is achieved.

Literature cited and aknowledgments

EFSA, 2022. Draft: Re-evaluation of the risks to public health related to the presence of bisphenol A (BPA) in foodstuffs. Available at: https://connect.efsa.europa.eu/RM/s/publicconsultation2/a0l1v00000E8BRD/pc0109

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Further information

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