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Harmonizing exposure metrics and methods for sustainability assessments of food contact materials

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We aim to develop harmonized and operational methods for quantifying exposure to chemicals in food packaging specifically for sustainability assessments. Thousands of chemicals are approved for food packaging and numerous contaminates occur, e.g. through recycling. Chemical migration into food, as a function of the chemical, food, and package properties and storage conditions, is responsible for human exposure to many chemicals of concern. In addition to complying with regulatory standards, stakeholders concerned with environmental sustainability draw on strategies such as Life Cycle Assessment (LCA) and Cradle to Cradle to support packaging design. Each assessment has distinct context and goals, but can help manage exposure to toxic chemicals and other environmental impacts. Metrics and methods to quantify and characterize exposure to potentially toxic chemicals specifically in food packaging are, however, notably lacking from such assessments. Furthermore, previous case studies demonstrated that sustainable packaging design focuses, such as decreasing greenhouse gas emissions or resource consumption, can increase exposure to toxic chemicals through packaging. Thereby, developing harmonized methods for quantifying exposure to chemicals in food packaging is critical to ensure 'sustainable packages' do not increase exposure to toxic chemicals. Therefore we developed modelling methods suitable for first-tier risk screening and environmental assessments. The modelling framework was based on the new product intake fraction (PiF) exposure metric, with units of chemical mass taken in by exposed persons versus chemical mass within a product. To model this metric, we used analytical approximations for regulatory models. We investigated model results for various chemical-package-food combinations to facilitate operation in assessments and identify combinations of priority.
Modelling results predicted with accuracy previous findings, that exposure is dependent on diffusive and partitioning behaviors according to each chemical-package-food combination. Harmonizing exposure modeling with environmental assessments, like LCA, finally facilitates including exposure to chemicals as a sustainable packaging design issue. Results were demonstrated in context of the pilot-scale Product Environmental Footprint regulatory method in the European Union. Increasing recycled content, decreasing greenhouse gas emissions by selecting plastics over glass, and adding chemicals with a design function were identified as risk management issues.
We conclude developing an exposure framework, suitable for sustainability assessments commonly used for food packaging, is feasible to help guide packaging design to consider both the environment and human exposure. Future work is required for refinement and operationality. This is the first study addressing the need for quantitative, harmonized exposure metrics and methods for food packaging within sustainability assessment frameworks.