COLLEGE ED BIOLOGIE DOCTORAL SANTE PAYS DE LA LOIRE

Year 20 /20

THESIS TOPIC

Subject N° (to be completed by the ED):	**FUNDING:** ☐ **Requested** **X Acquired**	**Funding origin: ONIRIS & McGill**
Thesis title: **CONTRIBUTION OF MICROPLASTICS TO CONSUMER EXPOSURE TO CHEMICAL CONTAMINANTS**		3 keywords: Risk Assessment, Chemical Food Safety, Microplastics, Organic Contaminants
Unit / team: **UMR 1329 LABERCA**		
Supervisor's name: **Dr DERVILLY Gaud**		Phone number: 0240687880 Email address: gaud.dervilly@oniris-nantes.fr

Socio-economic and scientific context (approximately 10 lines):

Plastics are inexpensive and versatile materials that make up many essential everyday items such as food packaging, water bottles, single- use medical supplies, and textiles that improve the quality of human life. Therefore, plastic use increased by more than two orders of magnitude from 1950s to 2020s, from 2 million to 367-381 million tons per year (PlasticsEurope, 2021). However, this production causes ~8 million tons of global annual plastic disposal to the environment and its pollution to the environment and human beings has therefore become the focus of attention. It is estimated that 10% of all plastics produced since their invention have ended their lives in the oceans. Plastics not only pollute the environment as a large waste but also become microplastics (MPs) and nanoplastics (NPs). MPs and NPs (M/NPs) are plastic particles of micron and nano size that are broken and decomposed by plastic waste under various external conditions such as ultraviolet irradiation, hydraulic erosion and biodegradation. With the increasing input of M/NPs to the environment, M/NPs' pollution has become a global problem and concern. In particular, regarding human exposure, there are three main ways for M/NPs to enter the human body: ingestion, inhalation and direct contact. Ingestion is the main way for human exposure to M/NPs, it occurs through food and beverages (EFSA, 2016, 2020). The specific issue associated with M/NPs is linked to their potential to adsorb chemical contaminants on their solid surface, making them more bioavailable to some organisms. Microplastics can thus serve as adsorbents owing to their high surface areas and then shuttle chemicals into organisms when ingested.

Working hypothesis and aims (approximately 8 lines):

So far, studies on microplastics were limited to a few beverages and food, whereas seafood and drinking water have been more studied. Publications mainly report migration of plastic-additives (e.g. Bisphenol A) from packaging by leaching (Xu et al., 2023), while microplastics-bound micropollutants is less studied leading to a lack of knowledge. No state-of-the-art review exists on contamination of food and beverages from microplastics and plastic-associated contaminants in the literature up to date. In its scientific opinions on the subject, the European Food Safety Authority (EFSA) concluded that "data on occurrence in food, including the effects of food processing, […], should be produced" (EFSA, 2016, 2020). Further, the risk behind the long-term exposure of micropollutants associated with microplastics has not been discussed in the literature. Though the exposure risk of the associated micropollutants and microplastics may be considered negligible, the long-term exposure and accumulation may create chronic risks for the human health. Therefore, a critical assessment of the sources, migration pathways, abundance, exposure, and risk of microplastics and-associated micropollutants is timely important. Indeed, the complex matrix of food and the absence of standard procedures for analysis of microplastics and micropollutants exist as challenges. More investigations on the presence of microplastics and plastic-additives in food and beverage are therefore urgent needs to a better assessment of potential human exposure and human health risk. In this context, the aim of the PLASTOC project is to assess the contribution of chemical exposure of consumers caused by microplastics contained in foodstuffs.

Main milestones of the thesis (approximately 12 lines):

In order to assess the risk associated with the vectoring of chemical contaminants by microplastics contained in foodstuffs, the project comprises various stages including (i) the development of an analytical strategy for extracting microplastics from foodstuffs, (ii) the characterisation of extracted microplastics in terms of their contaminant content, (iii) the assessment of consumer exposure to chemical contaminants via microplastics. A panel of foods representative of various diets will be compiled and analysed in order to study the determinants of exposure ; the impact of food cooking/preservation methods on the exposure will also be studied.

Mass spectrometry will be at the heart of the PhD's developments. On the one hand, it will be the preferred tool for targeted characterisation of a wide range of contaminants adsorbed on microplastics, on the other hand, it will also be used in a high-resolution format (HRMS) to characterise a wide range of emerging contaminants using a non-targeted strategy. These new approaches represent a unique opportunity to characterise consumer exposure (the exposome) on a large scale.

The project is divided into 5 workpackages (WP), broken down into tasks (T) and deliverables (D), over 36 months (M):

WP1 - Bibliographical study
- T1.1 - Reviewing current knowledge of the vectoring of contaminants by microplastics
- T1.2 - Write a bibliographical report (M4) and a review (M12)
  - *D1.1 - Bibliographical report*
  - *D1.2 - Published review article*

WP2 - Analytical developments
- T2.1 - Development of a method for extracting microplastics

T2.2 - Development of a method for extracting contaminants from microplastics
D2.1 - Publication of the analytical strategy (M18)

WP3 - Characterisation of the contamination of microplastics contained in foodstuffs
T3.1 - Sampling, selection of foodstuffs, type of Total Diet Study, representative of different diet habits
T3.2 - Analysis of adsorbed contaminants in targeted mode
T3.3 - Analysis of emerging contaminants adsorbed in non-targeted mode
D3.1 - Available contamination data (M24)

WP4 - Assessment of induced consumer exposure
T4.1 - Calculation of exposures for different diets/target populations
D4.1 - Available exposure data (M36)

WP5 - Project management / Valorisation strategy
T5.1 - Project management (ISO9001 certification)
T5.2 - Steering meetings (LABERCA/ McGill)
T5.3 - Marketing strategy (articles/conferences/general public)
T5.4 - Dissertation writing
T5.5 - Thesis defence
D5.1 – Data Management plan available (M12)
D5.2 - Minutes of available steering meetings (M33)
D5.3 - Publication of at least 3 scientific articles in peer-reviewed journals with a high IF (M34)
D5.4 - Thesis manuscript (M34)
D5.5 - Thesis defense (M36)

Scientific and technical skills required by the candidate (2 lines):

Master in Analytical Chemistry, Mass Spectrometry, Targeted Analysis, Non Targeted Analysis, MS Data Processing and Analysis.

3 publications from the team related to the topic (last 5 years):

Godéré M, Cariou R, Padioleau A, Vénisseau A, Marchand P, Brosseau A, Vaccher V, Le Bizec B, Dervilly G. Polychlorinated Naphthalenes in Foods from the French Market: Occurrence, Dietary Exposure, and Evaluation of Relative Contributions to Dioxin-like Contaminants. Published as part of Environmental Science & Technology virtual special issue “The Exposome and Human Health” 2024;58:1721−1730. https://doi.org/10.1021/acs.est.3c07838

Simonnet-Laprade C, Bayen S, McGoldrick D, McDaniel T, Hutinet S, Marchand P, Venisseau A, Cariou R, Le Bizec B, Dervilly G. Evidence of complementarity between targeted and non-targeted analysis based on liquid and gas-phase chromatography coupled to mass spectrometry for screening halogenated persistent organic pollutants in environmental matrices. Chemosphere 2022, 293, 133615, https://doi.org/10.1016/j.chemosphere.2022.133615

Padioleau A, Cariou R, Guiffard I, Le Bizec B, Escher BI, Antignac JP, Dervilly G. Non-targeted analysis of lipidic extracts by high-resolution mass spectrometry to characterise the chemical exposome: Comparison of four clean-up strategies applied to egg. Journal of Chromatography B 2024;1232:123963. https://doi.org/10.1016/j.jchromb.2023.123963.

National and international collaborations:

This thesis project is part of an international co-supervision agreement between Oniris and McGill University in Montreal. The PhD student will spend 18 months at McGill in Canada, then 18 months at LABERCA in Oniris, France. The PhD student will also have the opportunity to take part in international conferences in the field, to strengthen his or her scientific network.