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Abstract: Investigating possible human health effects of micro- and nanoscaled plastic particles (PPs) is challenging for several reasons. Micro- and nanoplastics are complex mixtures of diverse geometries, shapes and sizes that can be based on different polymer types (e.g. polyethylene (PE), polyamide (PA), polyurethane (PU), polymethyl methacrylate (PMMA)). Additionally they contain additives (e.g. antioxidants, plasticizers, pigments) and several contaminants (e.g. remaining traces of catalysts, traces of monomers and oligomers). Moreover, they may act as carriers for environmentally persistent organic pollutants (POPs) like polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCB) or others (carrier hypothesis). There is no consensus yet which properties are most important for hazard assessment, or if all solid, persistent polymers should be assessed jointly. Thus, assessing possible hazards of PPs is a complex endeavor. Within the German BMBF funded project InnoMat.Life (www.innomatlife.de) we investigate a selection of different PPs, covering different polymers (e.g. PE, PA, PU) with broad size distributions. In a first step adsorption and desorption of selected POPs are assessed. In parallel, we conduct in vitro-based studies using different cell models (intestinal, liver and lung cell models). These data will complement a planned in vivo study.

All materials of the study are relevant for industrial applications (e.g. for additive manufacturing), and were specifically selected or synthesized for the project. PE was chosen as a benchmark material. In addition, several types of PA (PA-6, PA-12), PU (4 variants), PMMA (2 variants) and a rubber material obtained from recycled truck tires were included. For assessing the sorption of PAHs benzo[a]pyrene was selected as a lead substance along with dibenzo[a,l]pyrene and anthracene. Firstly, we developed a universally applicable third polymer-phase partitioning (TPP) method, which enables us to quantify the sorption of POPs on various PPs without filtration. By this we analyzed the sorption of benzo[a]pyrene for 20 different PPs, including some aged polymers. Furthermore, the sorption of anthracene and dibenzo[a,l]pyrene was studied for selected PPs. The TPP method was validated using the commonly applied batch method.

In parallel, we investigated the biocompatibility of the PPs in three selected cell models, human intestinal epithelial Caco-2, human liver epithelial HepG2 and rat alveolar macrophages NR8383. In addition, the possible carrier effect of PPs was investigated for benzo[a]pyrene (BaP) and for two heavy metals in HepG2 and Caco-2 cells, by evaluating CYP1A1 expression and cytotoxicity, respectively.

Using the TPP method, we could show that the PPs strongly differed in their sorption behavior with surface area and hydrophobicity being the most influencing factors. That enabled us to rank and to categorize the PPs. All PPs investigated so far were not cytotoxic and no evidence was obtained supporting the carrier hypothesis. On the contrary, a few PPs tended to decrease the bioavailability of the selected pollutants. Of note, PPs derived from tire rubber were found to induce CYP1A1 expression in both cell lines even in the absence of pollutants.

Overall, data from this project will foster our understanding of possible human health hazards of PPs and, by this, contribute to the ongoing discussion about micro- and nanoplastics. From the material perspective, the investigations shall also provide new criteria for grouping of different PPs.

The role of Food Safety Agencies in the evaluation, communication and management of risks associated with microplastics in food

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Abstract: The environmental impact of micro- and nanoplastics has been of concern for many years but their potential to be transferred between trophic levels has only recently been identified as a global challenge. Therefore, the assessment of dietary exposure to microplastics constitutes now a primary challenge for all food safety agencies including the Spanish Agency for Food Safety and Nutrition (AESAN).

Accurate data on the presence of microplastics in food and drinking water are not available to assess the exact exposure of humans to micro- and nanoplastics through diet primarily due to the lack of standardized methods for analysis (Hartmann et al., 2019; Toussaint et al., 2019). Recent reports of

the reference Agencies of Food Safety (Science Advice for Policy by European Academies (SAPEA, 2019), Norwegian Scientific Committee for Food and Environment (VKM, 2019), Spanish Agency for Food Safety and Nutrition (AESAN) confirm this lack of quality and comparable data.

Although the lack of data to perform human exposure assessments is a major constraint, in the absence of total dietary exposure studies to plastics in humans, some estimates from some food groups identify marine foods as the main source of dietary exposure to plastics, micro- and nanoplastics that pollute the environment and that access the food supply.

The risks derived from the dietary intake of microplastics may be minimal compared to exposure through other routes like inhalation (Catarino et al., 2018). Nevertheless, there is also a lack of experimental data to perform a toxicity characterisation in humans and the potential health effects (the identification of dose-response relationships and threshold levels) of micro- and nanoplastics in consumers are still unknown and require further research.

Although micro- and nanoplastics in all food supplies and dietary exposure have not yet been assessed in Spain, the Spanish Agency for Food Safety and Nutrition (AESAN) noted a growing public and scientific concern about this topic and a mandate to its Scientific Committee was generated. Thus, the AESAN Scientific Committee considered a priority for 2019/2020 to publish a scientific report in order to improve the consumer's perceptions, reviewing information and data summarizing the status of knowledge of micro- and nanoplastics and its additives in foods. The Scientific Committee of AESAN made its own systematic literature search and 147 scientific references were reviewed from differing international sources in order to provide an overview of actual initiatives and future perspectives and opportunities in this research field.

A scientific report based on solid scientific data has been published to communicate the actual knowledge on micro- and nanoplastics and its additives in foods and to contribute to a better understanding of the dietary sources and the levels of dietary exposure to these contaminants. The report characterizes the current knowledge and highlights the gaps. This official report is intended not only to improve the consumer's perceptions of micro-nanoplastics in food but also the scientific community. Identifying the most relevant dietary sources of microplastics, the occurrence of the different molecules and polymers and their relevance in terms of exposure will help to focus future research projects, regulatory initiatives and monitoring programs at a regional, national and international level. It is the interest of the Spanish Food Safety Agency (AESAN) to promote research on microplastics in the food supply and fill the gaps where specific data are needed. Assessing the Spanish population dietary exposure to microplastics should be a challenge for our Food Safety experts and networking among the research groups should be promoted through our national food agencies and EFSA with the objective of assessing the dietary exposure to micro- and nanoplastics across the different countries and its populations.

Finally, a cross-nation diffusion of this report will be strategically designed.

Micro- and nanoplastics are emerging risks that are not yet fully understood but evidence regarding their toxicity is emerging. The lack of extensive knowledge on the toxic kinetics and toxic dynamics of these pollutants and their health effects prevents a solid risk characterisation. Evaluating the risks from micro- and nanoplastics requires knowledge of the hazard, exposure levels, and their effects. Risks associated with intake of microplastics are a function of hazard and exposure and tolerable daily intakes (TDI) for plastics and the different molecules have not yet been established.

Methods are available for identification and quantification of microplastics in food, but occurrence data are limited and a consensus on the micro- and nanoplastics definitions and descriptions, the standardisation of methods of analysis is needed for a better comparison and monitoring of the global results. For nanoplastics, no analytical methods or occurrence data in food are available and should urgently be developed, standardized and harmonized.

It is necessary to implement innovative solutions to mitigate/minimize humans' dietary exposure while regulating maximum levels of their main molecules or particles in different food sources. At present, the global commitment to reduce, reuse or recycle plastic materials keeps on being the best tool to minimize the environmental and health impact of these pollutants.

For a better understanding of the current state of play and ongoing research on this topic and to improve the knowledge and perceptions of consumers on micro- and nanoplastics in food, global

communication campaigns and informative materials should be designed considering multicultural perspectives.

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Developments in understanding consumer perceptions of micro- and nanoplastics in food

Understanding the public's perception of nanomaterials and how their safety is perceived in the EU – ECHA procurement procedure

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Abstract: In 2019, the European Chemical Agency launched a study on understanding the public's perception of nanomaterials and how their safety is perceived in the EU. This study aims to examine some of these questions and provide insight into the perception of risks associated with nanomaterials for citizens so that the European Union Observatory for nanomaterials communications approach can be adapted to address these perceptions in an informed way. The main point of the study is to extensively answer the following questions:

- Are consumers aware of what nanomaterials are?
- Are consumers aware of where nanomaterials are used?
- What risks do consumers associate with nanomaterials?
- What benefits do consumers associate with nanomaterials?
- How do consumers think they are exposed to nanomaterials?
- Are consumers concerned about nanomaterials in the products they use?
- Are there specific areas that consumers are particularly interested in but feel they do not have sufficient information available?
- Who do consumers trust most for information on nanomaterials (authorities, companies, ngos, others)?
- What source do consumers use when looking for information on the safety and risks of nanomaterials?

The study consisted of an extensive literature search of reliable surveys on public perceptions of nanomaterials, which lead to the compilation of a survey questionnaire. This data collected through the survey questionnaire are analysed and conclusions are drawn.