TOX/2020/40

COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

Overarching statement on the potential risks from exposure to microplastics

Background

1. In October 2019, the COT considered the potential health effects of microplastics in the diet by reviewing the currently available literature (TOX/2019/62)[1] The interest in this topic stemmed from horizon scanning activities. The following comments were made.

2. The Committee noted the importance of good physicochemical property data on nano- and microplastics, and the generation of refined exposure datasets, however, it was acknowledged that existing methodologies were not readily available and that the gathering of information on total dietary intake of microplastics would be difficult. Although the concentrations present in food and water, compared to airborne exposure to microplastics was thought to be lower.

3. It was highlighted that exposure to microplastics via inhalation might be easier to assess compared to oral exposure as occupational data from synthetic textile workers were available, however, the context should be considered. The concentrations present in food and water, compared to airborne exposure to microplastics was thought to be lower.

4. Based on the available data, it was considered that microplastic exposure *via* oral exposure did not indicate a concern for human health. Similarly, based on the available data, adsorbed compounds on microplastics, did not seem likely to pose a health concern to humans via the dietary route as the concentrations involved would be low. Chemicals leaching from microplastics could originate from other sources, not just microplastics, therefore their contribution to overall exposure of a particular chemical may range from not of significance to a level that could cause adverse human health effects.

[1] TOX/2019/62 is available on the COT website.

5. In terms of nanoplastics, it was asked whether there were existing pathophysiological data on human health – as these would provide better understanding on molecular interactions and which cells and organs were sensitive. However, proving an organ level effect was difficult. Furthermore, *in vitro* to *in vivo* extrapolation had limitations and conclusions were often non-transferrable.

6. It was noted that there was a great variability in the definition of microplastics and to define them appropriately would be a challenge, however, it was acknowledged that in the context of nanomaterials in food, a useful definition had been set out by the EFSA.

7. The Committee agreed that on the basis of the data in TOX/2019/62, a risk assessment could not currently be performed due to the lack of relevant human or related data and that a draft statement should be prepared by the Secretariat, highlighting other sources of exposure and key research needs.

8. It was proposed that an initial risk assessment could be based on microplastic exposure from tyre wear. The Committee expressed a preference for UK data in risk assessment models. However, if unavailable, non-UK data with the appropriate conversion factors if needed would be considered appropriate.

9. In March 2020, the COT reviewed the first draft statement on the potential toxicological risks from exposure to microplastics (TOX/2020/15)[2].

10. A number of general comments were provided on the structure and content of the draft statement. These included the lack of discussion regarding dose metrics, issues regarding the expression of exposure and the assessment of study quality. It was noted that microplastics in some foodstuffs (*e.g.* beer, salt and honey) were easier to identify/analyse due to the physical state of the food (*i.e.* liquid or readily dissolved) and therefore were easier to analyse. Overall, the Committee concluded that data were available on an insufficient range of foodstuffs.

11. The Committee agreed that it was important to distinguish between uptake across the GI tract and uptake into internal tissues. Particles <50 µm could be absorbed from the gut *via* tight junction gaps and by phagocytic and endocytic pathways but only those of <1-2 µm in size were able to cross cell membranes of internal organs.

12. Figure 5 of the draft statement, a flow chart which summarised the adverse effects of micro and nanoplastics in animal health, was discussed. It was not clear in which species the reported adverse outcomes had been observed, and it was likely that the figure represented a compilation of all adverse effects seen across diverse species.

[2] TOX/2020/15 is available as four documents on the COT website; comprising of the cover page, Annex A – which is the proposed first draft statement, Annex B – which provides a background on tyre and road wear particles and Annex C – which is details an update on the literature.

13. Information was provided on adverse effects from microplastics to aquatic organisms. The Committee agreed that the focus should be limited to those studies that were of potential relevance to human health.

14. It was agreed that historic data on medical implants, human epidemiology on particles in ambient air and occupational exposure to inhaled plastic fibres should be further reviewed for relevance to potential effects from exposure to microplastics in foods.

15. The Committee considered that the current literature data on the effects of plastic particles on the microbiota could not easily be compared and so it was difficult to draw any meaningful conclusions from these studies.

16. The Committee concluded that the literature data on exposure to particles from tyre wear would need separate consideration from microplastic exposure from food, since the particles were chemically quite different in their polymeric nature. Risk assessment of such material was considered potentially outside the scope of the current exercise.

17. The Committee acknowledged that the available data had been reviewed in some detail, but it was not all relevant to microplastics in food. It was agreed that the problem formulation should be clarified, with the microplastics under consideration being clearly defined. This would allow a more focused statement linking to the discussion papers to be prepared.

18. The draft overarching statement, as presented in Annex A brings together the discussions that took place at the COT meetings from October 2019 – March 2020, and summarises the conclusions reached to date, and explains the current state of knowledge, data gaps, and research needs with regards to this topic. Following the finalisation of the draft overarching statement and its publication, it is intended that additional sub-statements are to be drafted which address particular exposure routes or other materials (*i.e.* tyre and road wear particles).

19. COT Members are informed that invited experts from other government departments (*i.e.* Public Health England and the Environment Agency) and UK government advisory committee (*i.e.* Committee on the Medical Effects of Air Pollutants; COMEAP) with an interest in microplastics are present for this meeting in order to facilitate the points addressed in paragraph 16.

20. The COMEAP have previously published a statement on the evidence for differential health effects of particulate matter according to source or components in 2015[3]. In this, the toxic mechanism of metals (present in non-exhaust sources of

[3] The COMEAP statement is available on the UK government website.

particulate matter such as brakes and tyres) in exerting health effects were associated with its high oxidative potential.

21. COT Members have been provided a pre-publication copy of the COMEAP's statement on non-exhaust emissions for review and background information.

Update on literature

22. A short update on the emerging literature is provided in the following paragraphs.

Toxicological data

In vivo

23. Halden *et al*., (in press) have reported that they are among the first to examine micro- and nanoplastics in human organs and tissues. A press release was recently held in August 2020 by the American Chemical Society to discuss their findings[4]. In brief, the group analysed the presence of micro- and nanoplastics in 47 human tissue samples (from Alzheimer's patients) including samples from the lungs, liver, adipose tissue, spleen and kidneys using two methodologies.

24. Firstly, samples (n=47) were spiked and were analysed with flow cytometry, and this information on plastic particle count was converted into units of mass and surface area (by using a computer program). Secondly, mass spectrometry was utilised to analyse non-spiked samples (n=47). Plastic contamination in the form of monomers were reported for all samples. Bisphenol A (a common plastic additive) was found in all samples.

25. It should be noted that the inclusion of the above reference should be regarded as for information only since the article was not available at the time of drafting. Additionally, one of the main points discussed at the press conference was the study was carried out to develop a new methodology to detect particles in human tissues.

In vitro

26. Liu *et al*., (2020) investigated the influence of the digestive process on intestinal toxicity of spherical polystyrene microplastics (PS-MPs) (100 nm and 5 µm) by utilising Caco-2 models. The morphology of the particles was analysed by transmission electron microscope, whilst the composition was determined by Fourier transform infrared spectroscopy (FT-IR).

[4] Further details on the press release are available on the American Chemical Society website.

27. Results showed that the digestive process did not alter the chemical constitution of PS-MPs, but the formation of a surface corona were observed. Protein contents reached ~50 and 25 µg/mg for 100 nm and 5 µm PS-MPs, respectively. An increase in size to 440.2 nm was reported for the 100 nm size group following the digestive process.

28. Smaller sized particles (100 nm) were reported to have higher intestinal toxicity than larger sized particles (5 µm). Tested concentrations were 0, 1 and 20 µg/mL. The *in vitro* digestive process increased the pro-inflammatory effects of polystyrene microplastics, which was associated with the formation of the surface corona affecting the size, zeta potential, and affinity for adsorbed compounds of polystyrene microplastics.

29. Dong *et al*., (2020) investigated the toxicity of spherical PS-MPs with a rough surface on human lung epithelial (BEAS-2B) cells. The average particle size and zeta potential were ~1.8 µm and ~-27 mV, whilst the average hydrodynamic diameter was ~4 µm. Cells were exposed to 0, 1, 10, 100, and 1,000 mg/cm^2 for 24, and 48 hours.

30. Results revealed that PS-MPs can cause cytotoxic and inflammatory effects in BEAS-2B cells by inducing reactive oxygen species formation. PS-MPs decreased transepithelial electrical resistance by depleting tight junction proteins. Decreased α1-antitrypsin levels in BEAS-2B cells were also observed. It was suggested by the authors that, exposure to PS-MPs increases the risk for chronic obstructive pulmonary disease, and high concentrations of PS-MPs can induce these adverse responses. While low PS-MP levels can only disrupt the protective pulmonary barrier, they may also increase the risk for lung disease.

Exposure assessments

Oral

31. Conti *et al.,* (2020a) investigated the presence of microplastics (<10 µm) in fruits (apple and pear) and vegetables (carrot, lettuce, broccoli, and potato) (n= 6 each; collected from six different sites of the city of Catania), and further aimed to identify and quantify the number of microplastics using an Italian patented method (Ferrante *et al*., 2020), in order to assess the estimated daily intakes of microplastics from these food commodities.

32. Samples were washed and blended to collect in a control environment (*i.e.* avoided use of plastic based equipment, laminar flow hoods *etc.*), and were digested using nitric acid. Six reagent blanks were examined to check-cross contamination by the analytical process. Samples were then analysed using scanning electron microscopy combined with an X energy dispersion detector, which was reported to have a sensitivity of ~49 particles/10 g of extract over an approximate area of 490 mm^2.

33. The higher median level of microplastics in fruit and vegetables was 223,000 (52,600-307,750) and 97, 800 (72,175-130,500), respectively. The most contaminated fruit was apples, whilst carrot was the most contaminated vegetable. Carrots were also found to have the smallest size of microplastic size reported (~1.5 μm), the largest were observed in lettuce at ~2.5 μm. The estimated daily intake from ingestion of apples in adults and children were 4.62 E+05 and 1.41 E+06 particles, respectively.

34. It should be noted that the study by Conti *et al*., (2020) lacks transparency with regard to the utilised methodology and, as such, the presented results should be regarded with caution.

35. Ribeiro *et al*., (2020) performed a quantitative analysis of selected plastics (polystyrene, polyethylene (PE), polyvinyl chloride (PVC), polypropylene, and poly(methyl methacrylate) in Australian seafood (oysters, prawns, squid, crabs and sardines; n= 10 each) *via* pyrolysis gas chromatography mass spectrometry. Note that each specimen was weighed and washed prior to dissection to remove any traces of plastics. Only the edible part of each animal was dissected for analysis.

36. PVC was detected in all samples and PE at the highest total concentration of between 0.04 and 2.4 mg/g of edible tissue. Sardines contained the highest total plastic mass concentration (0.3 mg/g of edible tissue) and squid the lowest (0.04 mg/g tissue). It was observed that the total concentration of plastics is highly variable among species and that microplastics concentrations differs between organism of the same species.

37. Ribeiro *et al*., (2020) estimated the potential plastic exposure from consumption of seafood (in mg) per gram of average serving weight these were: squid at 0.7, oysters at 0.7, prawns at 1.1, crabs at 3.0 and sardines at 3.0 mg.

38. The average serving weights were 100, 50, 75, 100, and 100 g, respectively. The possible sources of plastic contamination in seafood were proposed to be from the potential transfer of microplastics from the gastro-intestinal tract to the flesh during food processing and handling, contamination from airborne particles, and from food packaging. The latter was hypothesised since most of the packaging used for the seafood purchased was made out of low-density polyethylene, and it has been reported that opening of plastic containers or bags can generate between 0.5 and 250 mg/cm^2 (Sobhani *et al*., 2020). Meat packaged in plastic food trays were also found to be contaminated with microplastics ranging from 4-19 particles/kg (Kedzeirski *et al*., 2020).

Air

39. Mini-reviews of microplastics in the atmosphere and their risks to humans have been published by Chen *et al*., (2020) and Huang *et al*., (2020).

40. Highlights from the Chen *et al*., (2020) review includes that microplastics are ubiquitous in the atmosphere, wind can transport microplastics through the atmosphere

over a long distance, meteorological conditions and human activities affect the concentration and deposition of microplastics, and that the inhalation of microplastics may pose as a health risk to humans (resulting from oxidative stress).

41. Highlights from the Huang *et al*., (2020) review includes the presence of microplastics in suspended particulates, atmospheric fallout, and dust. Fibres were commonly more detected than other shapes (*e.g.* fragments, granules, spheres *etc*). The potential sources, dispersion and deposition of airborne microplastics were also discussed. The authors considered synthetic textiles as an important source for airborne microplastics, other identified sources include fibres used in soft furnishings: carpets, curtains, synthetic upholstery *etc.* Human exposure to airborne microplastics *via* inhalation and dust ingestion were also summarised, although the data gathered was not of direct relevance to the UK population. The authors concluded that pre-treatment of samples should be standardised and that additional methodologies for chemical identification such as hyperspectral imaging techniques are expected to be used for the analysis of airborne microplastics.

42. Wright *et al*., (2020) reported atmospheric deposition of microplastics for Central London. Samples were collected ~50 m above ground level at 51.5111° N, 0.1171° W from 19th of January – 16th of February 2018 (n=8; 3-4 day sampling periods), which were initially filtered onto 0.2 µm pore size alumina-based membrane filters, and then transferred to silver membrane filters (1.2 µm pore size) to facilitate spectroscopic analysis. Nile Red stain was utilised to facilitate the identification and analysis of samples, whilst the determination of the chemical composition was verified using FT-IR.

43. Deposition rates ranged from 575-1,008 microplastics/m^2/day. Various shapes were detected, however, fibrous microplastics accounted for the majority of those observed (92%). Most analysed fibres consisted of cellulose (69%), which suggested that cotton and other plant fibres, either from natural or anthropogenic sources, are the predominant fibre type in the air. Local source areas of microplastics were analysed using bivariate polar plots, which indicated dependency on wind, with different source areas for fibrous and non-fibrous airborne microplastics. Across all samples, 15 different petrochemical-based polymers were identified of which polyacrylonitrile was the most commonly detected (~67%), followed by polyester (~19%), polyamide (~9%), and other (~5%).

44. Zhang *et al*., (2020a) (abstract only) reported varying microplastics fallout concentrations in different indoor environments (dormitory, office, and a corridor) on both workdays and weekends for 3 months. Amongst the three sampling sites, the highest average microplastic abundance was detected in the dormitory at 9,900 microplastics/m^2/day, followed by the office at 1,800 microplastics/m^2/day, and the corridor at 1,500 microplastics/m^2/day. The dormitory levels increased ~ 3 times during the weekend, whilst a reduction of ~50% in the levels was observed in the office. Microplastic fallout existed mostly in the form of fibres and showed similar polymer

compositions to the textile products used in indoor environments. Greater resuspension of microplastics were also observed in tests with an active air conditioner.

45. Zhang *et al*., (2020b) identified microplastics (polyethylene terephthalate; PET and polycarbonate; PC based) in indoor dust from 12 countries collected from 2010-2014 (total=286; China (n=39), Colombia (n=45), Greece (n=26), India (n=33), Japan (n=5), Kuwait (n=18), Romania (n=21), Pakistan (n=25), Saudi Arabia (n=30), South Korea (n=16), United States (n=10), and Vietnam (n=18)) and associated human exposure in different age groups (infants, toddlers, children, teenagers and adults).

46. PET-based microplastics were detected in all dust samples at concentrations of 38–120,000 µg/g (median: 5900 µg/g), whereas PC-based microplastics were measured at <0.11–1700 µg/g (median: 8.8 µg/g). Significant positive correlations were found between the concentrations of terephthalic acid (a PET monomer) and PET, as well as between bisphenol A (a PC monomer) and PC. Based on the concentrations of microplastics measured in indoor dust, the median daily intake of PET-based microplastics calculated for infants was in the range of 4000–150,000 ng/kg-bw/day.

Questions on which the views of the Committee are sought

47. Members are invited to consider the following questions regarding the first draft of the overarching statement and to raise any other matters that arise from the newly submitted data:

i). Does the Committee agree with the approach of having an overarching assessment which is to be followed by subsequent sub-statements that address particular exposure routes and/or materials?

ii). Do Members have any comments on the additional information presented in this cover paper?

iii). Are there any aspects that have been addressed during the COT review of microplastic exposure that are not covered in the draft overarching statement which should be included?

iv). Do the conclusions accurately represent the views of the COT?

v). Does the Committee have any other suggestions regarding data gaps and future research ideas?

vi). Do the members have any other comments on the structure and content of the statement?

Secretariat
September 2020

Abbreviations

COMEAP	Committee on the Medical Effects of Air Pollutants
COT	Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment
PC	Polycarbonate
PE	Polyethylene
PET	Polyethylene terephthalate
PS-MPs	Polystyrene microplastics
PVC	Polyvinyl chloride

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