Meeting

Discussion paper on Ocean Bound Plastic

This is a paper for discussion.

This does not represent the views of the Committee and should not be cited.

Background

1. The UK's Food Standards Agency (FSA) has recently become aware of plastic materials intercepted before entering the oceans (henceforward referred to as ocean bound plastic) being used in food contact applications on the UK market. Colleagues in the food contact materials (FCM) policy team sought an initial opinion of the Joint Expert Group on Food Contact Materials (FCM JEG) as to whether ocean bound plastic (OBP) could safely be utilised in food packaging, either directly or behind a functional barrier. They were especially concerned regarding substances that are mutagenic, carcinogenic or toxic to reproduction (CMR) and whether their absence could be guaranteed.

2. Following discussions held in 2021, the FCM JEG published an interim position paper on OBP in February 2022 and the FSA launched a call for evidence in March 2022 to obtain further information from industry, the individuals as consumers, or interested parties. The COT discussed the draft interim position paper in May 2021 and were updated on progress in July 2021.

3. The following paper briefly summarises the concept of OBP, its current uses on UK market and its potential safety implications on human health.

Introduction

4. Plastic pollution is an emerging environmental hazard affecting both terrestrial and marine environments. The annual production of plastic increased

from 1.7 million tonnes in 1954 to 368 million tonnes in 2019 (Plastics Europe, 2020). It has been estimated that around 4900 million tonnes, representing 60% of all plastics produced between 1950s and 2015, has been discharged in landfills or in the natural environment (Geyer, 2017).

5. The majority (80%) of plastic in the ocean originated from land, mostly from coastal areas (Wayman, 2021). It has been estimated that 19 - 23 million metric tonnes (11% of plastic waste generated globally in 2016) has entered the aquatic ecosystem. An increase of plastic emissions of up to 53 million metric tonnes per year to aquatic ecosystems is expected by 2030 (Borrelle, 2020).

6. Lebreton et al. (2017) described a complex model of plastic input from rivers into oceans based on waste management, population density and hydrological information. The authors estimated that a total of 1.15 – 2.41 million tonnes per year enter the oceans via rivers. The contribution from coastal areas (defined as areas within 50 km of the coastline) was estimated at 0.36 – 0.89 million tonnes per year. The remaining 0.79 – 1.52 million tonnes of plastic per year enters the oceans via rivers from inland (> 50 km form the coastline).

7. An analysis by Schmidt et al. (2017) estimated that 0.41 - 4 million tonnes of plastic debris enter the ocean via rivers per year. Ten rivers, located in Asia and Africa, were estimated to transport between 88 - 94% of the plastic delivered to the ocean. Hence, the authors concluded that potential mitigation measures in these areas would be highly effective and could significantly reduce the contribution of inland areas to ocean plastic.

8. Limitations in the current models, e.g. information on basin-scale geography, land use and climate, make it difficult however to accurately estimate plastic emissions.

9. Using observational data on macroplastics and a “distributed probabilistic model” Meijer et al. (2021) estimated the contribution of riverine macroplastic emissions to the ocean. The model included factors such as plastic transport, differences in land use, terrain slope and plastic retention in the environment. The authors estimated the annual global riverine plastic emission to be between 0.8 - 2.7 million metric tonnes, which was comparable with previous studies. However, the number of rivers considered in this study was significantly higher (N = 1656) than in previous studies.

10. Degradation of plastic materials presents a significant risk to marine and terrestrial environments as well as human health as smaller particles can be

ingested and potentially cross biological membranes and may affect cellular and subcellular processes (Syberg, 2015). Mechanical stress induces plastic fragmentation leading to a change in plastic size distribution. Increased surface to volume ratios of smaller particles after fragmentation accelerate physicochemical and biochemical reactions on the particle surface (Barnes, 2009; Syberg, 2015; Wayman, 2021). Mechanical weathering is influenced by environmental conditions and may be a significant mechanism in terrestrial environments. In a river system, abrasion and attrition occurs with sediment load, while agricultural practices may increase the fragmentation in soils. It has been suggested that due to increased exposure to degradative forces, degradation on land could be significantly higher than in aquatic ecosystems (Hurley, 2020).

11. Photooxidation is a radical based autoxidative process in which free radicals are formed when the light breaks chemical bounds in the main polymer. It occurs when the polymer contains chromophores that are able to absorb light and as a result of photooxidation, the physical properties of the material at molecular level are changed. Due to the lower temperature and oxygen availability, the photooxidation is significantly decreased in seawater (Gewert, 2015; Webb, 2013).

12. Biodegradation is a process in which the structure of the plastic is transformed or altered through metabolic or enzymatic action of microbial organism such as bacteria or fungi (Urbanek, 2018). Biodegradation may refer to partial changes in chemical properties of the plastic material or complete mineralisation where the plastic is transformed into small molecules, typically $CO2$ and $H2O$, and eventually removed from the environment (Andrady, 2017). If the metabolic products of microorganisms affect the structure of the plastic material, the biodegradation pathway is considered indirect, direct biodegradation occurs when the plastic material is a direct substrate for microbial growth (Caruso, 2015). Direct biodegradation can lead to biofilms forming on the (micro)plastic surface (Weinstein, 2016).

13. The different degradation pathways weaken the plastic material and its properties are changed, hence the potential re-use of the material can be affected. Partial degradation of plastic compounds can produce intermediates that can be a concern to human health (Andrady,2011), while plastic debris that was in contact with contaminated water or soil has the potential to absorb persistent harmful chemicals (e.g. heavy metals, persistent organic pollutants) (Andrady, 2017; Turner, 2016).

Definition of ocean bound plastic

14. The term ocean bound plastic (OBP) is currently used as an “umbrella term” covering a broad range of plastic disposed in the environment and the use of OBP in FCM products is a relatively new concept. There is no one accepted definition.

15. The concept of and term OBP itself is based on a publication by Jenna Jambeck (2015), in which a detailed model was used to estimate the amount of plastic waste generated annually by populations living within 50 km of a coastline. However, it should be noted that even though this publication has been used to loosely define OBP, the term was not actually used in the publication itself.

16. Further examples of defining OBP in the literature include a) abandoned plastic waste of all size that is located within 50 km from the shore in areas with poor or non-existing waste management systems, b) plastic waste in uncontrolled or informal dumps if located within 50 km from shore, c) abandoned plastic waste located within 200 m from rivers/streams and d) plastic that is located within 50 km from an ocean coastline or a major waterway (Zero Plastic Ocean; Prevented Ocean Plastic).

17. The term OBP generally seems to refer to plastic originating from countries with poor waste management infrastructure and/or existing infrastructures which are often overwhelmed by population growth or tourism. However, the initial publication by Jambeck (2017) used to define OBP considered coastal countries all over the world, including the USA and European countries. According to the authors, countries with good waste management systems however contributed significantly less to the overall amount of plastic emissions entering the ocean.

Use of OBP

18. The FSA and Food Standards Scotland (FSS) have become aware of the use of recycled plastic in FCM products on the United Kingdom (UK) market that are in part, or fully, fulfilled using plastic material that has been obtained from the environment (referred to as ‘ocean-bound’). The recycled plastic was obtained from the open environment (discarded plastic) or collected through systems other than municipal waste.

19. The plastic is collected by various systems and organisations, such as but not exclusive to private and organised collectors, non-governmental organisations (NGOs), governments and local community organizations. The bottles are then aggregated, sorted and sold to recycling facilities. From the limited information available, the material is then processed into usable plastic pallets, flakes, or yarn. Overall, there is limited or no information available on the supply chain, process, the quality control of the material or how compliance with EU/UK regulations is ensured. The recyclers and processors may be located outside of Europe and the UK and while they provide general statements on compliances and quality control, no data are provided.

20. Retailers including Sainsbury's, Waitrose, Aldi and Lidl are using food packaging containing ocean bound plastic. Lidl for example uses packaging made of OBP in their own-label fish and poultry product packaging, Aldi announced a new packaging initiative for its own-brand fishcakes and crisp bake ranges. Sainsbury's uses OBP in packaging for fish and some fruits.

21. BetterYou, a company specialising in health supplements, uses plastic packaging for their products entirely made of ocean recycled or plant-based plastic. Hip with Purpose sells a range of kitchen ware and water bottles that are created from OBP and are in direct contact with food or potable water in a case of water bottles. Further products using OBP include packaging for cannabidiol products, toys and accessories for animals, baskets and bags as well as cosmetic packaging.

22. While the above list may not be exclusive, the information demonstrates the initiatives by companies to tackle plastic pollution and use of OBP in food and consumer related materials. However, often limited information is available on the percentage of and/or which part of the product was made by OBP. Information on the type of recycled plastic, e.g. PET, PE, is predominantly not available.

23. The FSA's and FSS's call for evidence aims to answer some of the above uncertainties and data gaps. Business operators are asked to provide information how they propose to, or currently, carry out their own risk assessment to determine the safe use of recycled plastic that has been sourced from the open environment.

Safety implications

24. Food contact articles (FCAs) are used in the production, processing, transport, handling, and storage of food (Muncke, 2017) and are made of various

food contact materials (FCMs) such as plastic, paper, metal, glass, adhesive and ink. While their aim is to protect food from microbial spoilage, physical damage or soiling, chemicals can potentially migrate from FCAs into food and could affect human health (Muncke, 2017). However, migration of these potential chemical hazards from FCMs are regulated.

25. Recycling FCMs pose considerable challenges as the re-use of plastic materials increases the potential sources of contamination due to previous food contact, transport, disposal and possible misuse. Partial degradation can also potentially increase the levels and numbers of compounds that could migrate from packaging into food (Geueke, 2018). It is important to monitor the presence of non-intentionally added substances (NIAS) within recycled materials, because a) contaminants such as colourants, additives and their degradation products can be present in materials, b) degradation of the material may occur during use or recycling, c) accumulation of chemicals may occur each time the material is recycled, d) unwanted and/or unexpected contaminants can be present as a result of previous use or misuse and e) non-food grade materials may enter the recycling stream (Geueke, 2018).

26. Plastic packaging consists either of a single polymer such as polyethylene terephthalate (PET), polypropylene (PP), high (HDPE) and low (LDPE) density polyethylene, polystyrene (PS), or polyvinylchloride (PVC), or a combination of several types of plastic layers forming multilayer plastics. The efficiency of the recycling processes as well as the quality of the product largely depend on the physico-chemical properties and purity of the original plastic and the process conditions. The relatively high inertness of PET, its resistance to higher temperatures, and established collection systems make PET an established and easy material to recycle. All PET packaging resins sold by European manufacturers and placed on the EU market are required to be of food contact grade (EFSA, 2011).

27. Studies to establish the level of contamination of collected plastic predominantly focused on PET. In a European survey on post-consumer PET materials, washed and dried post-consumer PET flakes were obtained from thousands of soft drink bottles collected in 12 European countries (Franz, 2004; EFSA, 2011). Analysis of these materials revealed average and maximum levels of 18.6 and 86.0 mg/kg for acetaldehyde and 2.9 and 20 mg/kg for limonene, respectively. External contaminants from residues of other polymer types, such as phthalates, adipates and erucamide were present sporadically at levels lower than 0.2 mg/kg with the exception of one case in which dioctyl adipate was

present at 0.5 mg/kg. Misuse of bottles was reported in three cases; bottles were either filled with household chemicals, fuels or similar chemicals. In these instances, toluene was found in two of the bottles at 4500 - 6750 mg/kg PET and 2000 - 3000 mg/kg PET. Xylene was found at 2000 - 3000 mg/kg. Overall, common contaminants in postconsumer plastic packaging originate from food-related flavourings (e.g., limonene from beverages), cosmetics and personal hygiene products (e.g., methyl salicylate), but also from misuse of packing and cross contamination.

28. In a study by Bayer (2002), five different types of collected PET were investigated: four were food containers from deposit and curb side collection, one was non-food containers from kerb side collections such as mouthwash, shampoos or household cleaning products. The sum of all detectable chemical compounds found in food PET containers was estimated to be 28.5 mg/kg in washed and dried flakes, with limonene being the predominant contaminant at a maximum concentration of 18 mg/kg. For non-food containers the sum of all detectable chemical compounds was estimated to be 39 mg/kg in washed and dried PET flakes, with methyl salicylate (used in cleaning products or mouthwash) being the predominant compound at a maximum concentration of 15.3 mg/kg.

29. Camacho et al. (2000) analysed the quality of recycled resins of high density polyethylene (HDPE) and polypropylene (PP). Sixty-five different compounds were detected in recycled HDPE such as low concentrations of toxic aromatic hydrocarbons without functional groups (e.g. ethylbenzene (39 ppb), xylenes (35 ppb)). However, the concentrations of these contaminants were approximately five times higher in the recycled resins compared to virgin material. Recycled HDPE and PP samples also contained numerous migratable substances, that were not present in virgin material, such as hexadecenoic, octadecanoic acid, 6-dodecanon, limonene, 3-carene, betamyrcene and terpinolene.

30. Due to the lack of data on the contamination of plastic located in the open environment or OBP, information on ocean derived plastic and microplastic was used in the following sections to highlight some of the potential risks to human health.

31. Polychlorinated biphenyls (PCBs) were reported at a total concentration of 5 mg/kg in polystyrene spherules collected from the coastal waters near New England (Carpenter, 1972). No further testing was carried out, but the authors suggested that since PCBs are not added in the manufacturing of polystyrene, it is likely that seawater was the source of the contamination.

32. In a study published by Mato et al. (2001) PCBs, dichlorodiphenyldichloroethylene (DDE), and nonylphenols (NP) were detected in polypropylene (PP) resin pellets collected from four areas along the Japanese coast. Concentrations of PCBs (4 - 117 ng/g), DDE (0.16 - 3.1 ng/g), and NP (0.13 - 16 µg/g) varied significantly among the sampling sites. The authors suggested that chemicals were adsorbed by the plastic pallets from seawater. The nonpolar surface of PP resins, which is made of saturated hydrocarbons, can adsorb hydrophobic pollutants such as PCBs and DDE through hydrophobic sorption. Exposure to air for six days did not significantly increase the concentration of PCBs and DDE, suggesting that the atmosphere does not directly contribute to the contamination.

33. Mai et al. (2018; 2020) analysed microplastic samples (0.3 – 5 mm) collected from the surface water of eight main riverine outlets in the Pearl River Delta in China, flowing into the South China Sea over a period of 12 months. Organic pollutants (OPs) such as polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers (PBDEs), and PCBs were detected. The mean concentration of PAHs, PBDEs and PCBs were 2,010 ng/g (range: 25 − 40,100 ng/g), 412 ng/g (range: 0.84 − 14,800 ng/g), and 67.7 ng/g (range: 1.86 − 456 ng/g), respectively. Microplastics (0.33 – 5 mm), polystyrene foams, polyethylene films and lines were also collected from ten surface seawater sites in Bohai and Huanghai Seas, China. The concentration of the sum of PAHs was in the range of 3400 - 119,000 ng/g and depended on the location. While the authors did not exclude the plastic entirely as the source of PAHs they considered it highly unlikely that the manufacturing process was the only source. The concentrations of PAHs in the surface sediments (52 – 1,870 ng/g), coastal sea water (136 – 621 ng/L) and marine organisms (60 – 129 ng/g) indicated a possible adsorption of PAHs from the seawater.

34. Chen et al. (2018) compared chemical concentrations in plastics of different types and sizes collected from the North Pacific accumulation zone (NPAC). The NPAC is a major plastic accumulation zone for floating debris located in the North Pacific ocean between California and Hawaii. The concentrations of the persistent bioaccumulative toxic (PBT) chemicals detected are summarised in Table 1. No associations between plastic particle size and chemical concentrations were reported. This is due to the large variation in chemical concentrations found for each particle size.

Table 1: Persistent bioaccumulative toxic chemical concentrations in the analysed plastic samples from the NPAC (Chen, 2018).

Plastic type	Plastic size [cm]	∑ PAHs [µg/kg]	∑ PCBs [µg/kg]	∑ PBDEs [µg/kg]	HBCD [µg/kg]
Hard plastics	0.05 – 0.15	14.4 – 29.2	19.3 – 37.5	6.8 – 49.5[c]	21 – 160
	0.15 – 0.5	34.4 – 202.6[a]	12.1 – 81	5.1 – 32.3	3.1 – 76
	0.5 – 1.5	96.6 – 801.6[a]	4.6 – 78.7[b]	5 – 187.7[c]	0.03 – 740
	1.5 - 5	34.8 – 64.2	2.2 – 137.5[b]	6.1 – 18.2	0.01 – 0.9
	5 - 10	117.4 – 227.5	12.6 - 16	2.6 – 46[a]	0.02 – 2.7
	10 - 50	54.5 – 396.7[a]	9.9 – 135[b]	23.4 – 49.9	0.01 – 1.5
	> 50	185.9 – 847.7	2.8 – 93.1[b]	0.7 – 46.5	0.02 – 4.3
Nets and ropes	0.05 – 0.15	1.5	9.1	n.d.	n.d.
	0.15 – 0.5	1.2 – 193 860	6.5 – 9.8	n.d.	n.d.
	0.5 – 1.5	2.8 – 387.9	2.7 – 5.8[b]	0.6 – 1.3	n.d. – 1.8

	1.5 - 5	118.2 – 7236.1	94.2 -308.4[b]	0.6 – 4.3	0.04- 1.8
	5 - 10	9.5 – 142.6	0.7 – 4[b]	1.6 – 2.6	0.04 – 1.8
	10 - 50	133.7 – 284.5	1.6 – 455.1[b]	11.4 – 52.1	0.05 – 5.7
	> 50	46.3 – 680.5	0.8 – 41.7[b]	3.4 – 6.1	0.03 – 1.9
Pellets	0.15 – 0.5	61.7 – 101.6	1.6 – 8.1[b]	5.4 – 66.1	2 – 13

Concentration ranges are shown separately for all the plastic type/size categories, which had three samples each (sampling locations 1, 2, and 3). The exception is type “nets and ropes”, size class 0.05−0.15 cm, which only had one sample. PBDEs cells with an [c] indicates the presence of at least one sample with PBDEs composition similar to the flame retardant mixture formula Penta-BDE;74, PCBs cells with an [b] indicates the presence of at least one sample with PCBs composition similar to the commercial plasticizer Aroclor1254;99 and PAHs cells with an [a] indicates the presence of a sample with PAHs dominated by low molecular weight PAHs (LPAH).

Current legal position

35. This section briefly summarises the UK regulation on materials intended to come into contact with food .

36. The Materials and Articles in Contact with Food (England/Northern Ireland/Scotland/Wales) Regulations 2012 make provision for a purpose mentioned in European Communities Act 1972 and is expedient for certain references to Commission Regulation (EC) No. 2023/2006 on good manufacturing practice for materials intended to come into contact with food. These regulations covers offences of contravening specified provisions of Regulation 1935/2004, Regulation 2023/2006 and Regulation 10/2011.

37. RETAINED REGULATION (EC) No 1935/2004 (COMMISSION REGULATION No 1935/2004 for Northern Ireland) covers materials and articles intended to come into contact with food The traceability of the material intended to come into contact with food should be ensured at all stages. This regulation permits import of food packaging materials from developing countries as long as compliance with European legislation is verified. Materials should be manufactured in compliance with good manufacturing practice and the labelling, advertising or material presentation should not be misleading.

38. RETAINED REGULATION (EC) No 2023/2006 (COMMISSION REGULATION No 2023/2006 for Northern Ireland) covers good manufacturing practice (GMP) for materials and articles intended to come into contact with food. The regulation lists the rules of GMP and states that quality assurance should regularly be controlled to ensure the quality standards and compliance with regulations.

39. RETAINED REGULATION (EU) No 10/2011 (COMMISSION REGULATION No 10/2011 for Northern Ireland) amended REGULATION (EC) No 1935/2004 on the transparency and sustainability of the EU risk assessment in the food chain. This regulation covers plastic materials and articles intended to come into contact with food, specifically the use of non-authorised substances behind a functional barrier, as long as certain criteria are fulfilled and migration is below the analytical detection limit, a maximum level of 0.01 mg/kg. Mutagenic, carcinogenic or toxic to reproduction substances should not be used in food contact materials without previous authorisation. The compliance with the relevant regulations should be declared at each manufacturing stage. The FCM must only use substances listed in the retained list of authorised substances (the Union list in EU regulation) and they must be of technical quality and purity. The retained list of authorised substances is a list of authorised monomers, other starting substances, macromolecules obtained from microbial fermentation, additives and polymer production aids. Substances that are not in the retained list of authorised substances may be permitted in FCMs if they are behind a functional barrier and do not contain CMR properties.

40. RETAINED REGULATION (EC) No 282/2008 (COMMISSION REGULATION No 282/2008 for Northern Ireland) covers recycled plastic materials and articles intended to come into contact with foods and is the amendment to Regulation (EC) No 2023/2006. The regulation states that the quality of the plastic material must be characterised and controlled according to pre-established criteria and the material must originate from plastic material manufactured according to Community legislation.

41. From the limited information available, it is currently unclear whether OBP is manufactured in accordance with GMP and complies with the relevant regulations on materials and articles intended to come into contact with food. If retrieved from outside Europe the plastic may have been produced under a different regulatory regime with unknown consequences regarding its composition.

Discussion and conclusions

42. While there are potential environmental benefits of recycling OBP, there are currently significant data gaps in assessing the safety of recycled OBP. These include:

- a lack of specific data on the type and origin of the plastic
- a lack of studies on the presence of potentially hazardous substances

43. Assessment of manufacturer’s applications to the FSA which include recovered OBP would need to be considered on a case-by-case basis. Since applications using OBP are unlikely to have sufficient information on potential contamination and the extent of any previous degradation, the presence of potentially hazardous substances in this material is unknown. This results in uncertainties around the safety of the recovered plastic. At present it is also unclear whether packaging applications incorporating OBP could, depending on the material type, be further recycled.

44. Since OBP is predominantly sourced from countries with poor waste management infrastructures, information regarding how the original plastic packaging was handled, processed and therefore how it complies with EU and UK legislation is less likely to be available.

45. Currently, there is no clear definition of OBP which presents a potential problem as different manufacturers may define OBP differently.

Questions for the Committee

The Committee are asked to consider:

i) Given the call for evidence has been extended to environmental plastic, do the Committee have a proposal to clearly differentiate between environmental plastic and OBP? Or do the Committee consider it appropriate to extend the current definition to environmental plastic.

ii) How do the Committee define OBP/environmental plastic (e.g., distance to the coast).

iii) What sources of OBP do Members consider within/outside the scope of the current risk assessment, e.g., is the contribution from countries with established waste management systems considerable enough to be included in the assessment?

iv) Are there any contaminants or potential hazards the Committee would like to highlight/focus on?

v) What do the Committee consider the main data gaps? And what information would be useful to fill those gaps?

vi) What data do the Committee consider necessary for a useful risk assessment of OBP?

vii) Does the Committee have any other comments on this paper?

Secretariat

July 2022

List of Abbreviations and Technical Terms

CMR	substances that are carcinogenic, mutagenic, or toxic to reproduction
DDE	Dichlorodiphenyldichloroethylene
EDCs	Endocrine-Disrupting Chemicals
FCM	Food Contact Material
HDPE	High Density Polyethylene

JEG	Joint Expert Group
NP	Nonylphenols
NPAC	North Pacific Accumulation
OBPD	Ocean Bound Plastic
PAHs	Polycyclic Aromatic Hydrocarbons
PBDEs	Polybrominated Diphenyl Ethers
PBT	Persstent Bioacumulative Toxic
PCBs	Polychlorinated Biphenyls
PCR	Post-consumer Resin
PET	Polyethylene Terephthalate
POP	Persistent Organic Pollutants
PP	Polypropylene

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