Department for Environment, Food and Rural Affairs

Hazardous Substances Advisory Committee

HSAC view on the risk to the marine environment of microplastic in leave-on cosmetic and domestic cleaning products

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Background

Legislation introduced a ban on manufacture of microplastic in rinse-off products which came into effect on 1 January 2018 and a ban on sale by 30 June 2018. During the process of developing the ban, the Hazardous Substances Advisory Committee was asked by Defra to consider the following:

What evidence is there that microplastic found in leave-on cosmetic and domestic cleaning products have an impact on the marine environment? Is this impact significant? How reliable is this evidence?

The government, as part of the Resources and Waste Strategy published in December 2018, has pledged to eliminate all avoidable plastic waste from any source. This necessarily encompasses both macro and micro plastics. Government policy in this space is guided by the waste hierarchy, with priority going to ‘reduce’ (i.e. a reduction in the use of products/materials which become waste). According to the Strategy, to do this government generally prefers to help people and businesses make the right choice, for example through better consumer information or product labelling. There may, however be times where a ban is appropriate as part of a wider strategic approach, as demonstrated by the existing ban on microbeads in rinse-off personal care products.

Introduction to response

The term microbead (see full definition below) has become associated largely with the spherically shaped microplastic particles which are easy to identify visually and are used for the purpose of exfoliation and cleansing in “rinse-off” products. Microplastic is however also used in various forms in a range of other products, including domestic cleaning products and in leave-on cosmetics which are not included in the current legislation.

The use of microplastic in domestic cleaning products is intended to provide abrasive properties, or to act as emulsifiers, binders, fillers, surface films or slow-release agents. They typically can constitute 4% by weight of the final product [EC 2017].

In leave-on cosmetics, microplastic can form a major component of the ingredients. This includes common products such as face powders (approximately 99% Polyethylene), and mascara (approximately 45% Polyethylene terephthalate)[1]. Though plastic generally constitutes less than 1% of the product in the majority of cases, it is also present in lipsticks, blushes, eye shadow, make-up bases, sunscreens, foundations, shaving gels, and creams.

For the purposes of this document, the following definitions are applied. More detailed definitions can be found in [EC 2017].

Microbead

Under current legislation, the term 'microbead' refers to any water-insoluble solid plastic particle of less than or equal to 5mm in any dimension[2]. Microbeads are generally less than 1 mm in diameter. They are also used in biomedicine and as scrubbers in soaps, shower gels and toothpaste. Microbeads are estimated to make up around 2% of the 3.2 million metric tonnes of microplastics that enter the environment every year [Dauvergne, 2018].

Microplastic

The broad term 'microplastics' refers to plastic particles, beads, fibres or fragment of less than 5mm in size (National Oceanic and Atmospheric Administration (NOAA)). Although there is no international agreement on the definition, it is broadly supported internationally. Microplastic can form from the fragmentation of larger items (secondary microplastic), or are manufactured to be of this size (primary microplastic) [UNEP, 2016, GESAMP, 2015]. Microplastic generated during the use phase of the product is defined by GESAMP as secondary rather than primary. Primary microplastic is estimated to constitute around 15–30% of total plastic in the oceans [Boucher and Friot, 2017]. Major sources of primary microplastic pollution are the washing of synthetic clothing, wear from synthetic tyres and 'plastic dust' generated from areas of high human activity: e.g. breakdown from building materials and road surfaces, artificial turf and other consumer items [Kole et al., 2017].

Polymer/plastic

Cosmetics, personal care products and domestic cleaning products contain a wide and diverse array of polymers, which may have differing physical and chemical properties. Not all of them will fulfil the definition of ‘plastic’ as being a synthetic polymeric material made from organic monomers that can be moulded, extruded or physically manipulated into various solid forms and that retains its final manufactured shape during use in its intended application.

[1] http://www.eunomia.co.uk/report-tag/microplastics/
[2] The Environmental Protection (Microbeads) (England) Regulations 2017/1312

Neither do they fulfil the definition of a microbead, as above. Polymers with the same ingredient name may exist in several physical forms; e.g. as a solid plastic, or a non-solid, non-plastic thickening agent. Other uses of polymers include as liquid emulsion stabilisers, emollients, thickening or stiffening agents, stabilisers, slow-release agents, solubilisers or to impart viscosity, water-resistance or texture. Water soluble polymers are used as hydrogels, to impart water absorbing properties to items, e.g. nappies, but are not considered here given their water soluble nature.

The most commonly encountered polymers in domestic cleaning products according to [EC 2017] include polyurethane, polyester, polyamide, acrylic and polyethylene.

The most commonly encountered polymers in cosmetics according to the Cosmetics, Toiletry and Perfumery Association (CTPA) include acrylates, copolymer polyamides, polyethylene, poly(methyl methacrylate), polymethylsilsesquioxane, polysaccharides, polytetrafluoroethylene and styrene acrylate copolymers. The majority of these substances are governed by regulatory frameworks separate from legislation to control microbeads, for example, the US Environmental Protection Agency (EPA) guidance and the European or Organisation for Economic Co-operation and Development (OECD) Standards for biodegradation testing. ECHA offers further guidance for their treatment and classification[3].

Human health impacts are dealt with under the cosmetics regulation and REACH addresses environmental risks from non-polymeric ingredients e.g. in domestic cleaning products. REACH requirements currently do not apply to the polymers themselves.

According to EU Regulation 1223/2009 (article 2, 1.a), a cosmetic product is ‘any substance or mixture intended to be placed in contact with the external parts of the human body (epidermis, hair system, nails, lips and external genital organs) or with the teeth and the mucous membranes of the oral cavity with a view exclusively or mainly to cleaning them, perfuming them, changing their appearance, protecting them, keeping them in good condition or correcting body odours” [EC 2009].

Cosmetics can be further divided into leave-on and rinse-off products. A leave-on cosmetic is a product that for it to function is intended to stay on the skin for an extended period; perfumes, decorative cosmetics, body and face creams, and antiperspirants. A rinse-off cosmetic is a product designed to be rinsed off after a short stay on the skin or mucous membranes; shampoos, soaps, shower gels, and toothpastes.

Survey on consumer behaviour by Greenpeace

The basis for not including “leave–on” products on the proposed action to ban microbeads in cosmetics is that they are not designed to be rinsed off (and therefore enter the sewerage system and eventually the marine environment). Most of these products are designed to be removed with a tissue/cotton pad and disposed of in the bin.

[3] https://echa.europa.eu/guidance-documents/guidance-on-reach

However, a survey carried out in 2017 by YouGov, commissioned by Greenpeace[4], found that over 40% of respondents (2,141) washed off “leave-on” products or disposed of the tissue/cotton pad down the toilet after removal.

Capture of microplastics in waste water treatment

Previous studies have shown that waste water treatment plants can capture up to 90% of the plastic particles that enter the treatment facility [Magnusson and Noren, 2014, Carr et al., 2016]. Despite this large reduction, there is still high input from wastewater treatment works. For example, a study conducted in Scotland found that despite a removal rate of 98.4%, wastewater treatment works were still releasing 65 million microplastics into receiving waters every day [Murphy et al., 2016]. In the UK, sewage sludge that is retained is subsequently used on agricultural land for fertilizer and any microplastic present can then enter rivers and then the marine environment. Many of the microplastic particles used in leave-on products are also considerably smaller (<0.05mm) than those used in rinse-off products (0.1 mm - 5 mm). For example, microplastic particles added for additional protection in sunscreen are only 0.0003 mm in diameter. As such, many of these microplastics will pass through waste water treatment plants, even those with tertiary treatment facilities[5].

What evidence is there that microplastics found in leave-on cosmetic and domestic cleaning products have an impact on the marine environment?

There are currently no available methods that can distinguish the exact origin of most microplastic found in marine litter, other than to identify them to polymer type [Touissaint et al., 2018]. For this reason, it is not possible to distinguish microplastics in marine litter that originate from rinse-off products from those that originate in leave-on products. A significant fraction of leave-on products are likely disposed of down the drain, as evidenced by the Greenpeace consumer survey reporting that the majority of leave-on products will be rinsed off in a similar fashion to rinse-off products, (although they cannot currently be distinguished from each other in wastewater treatment effluents to confirm this directly, as noted above). The smaller size of microplastics in leave-on products increases the likelihood that they will pass through sewage treatment works.

Microplastic pollution is certainly widely detectable in municipal wastewater treatment plant effluent [Mason et al., 2016, Weithmann et al., 2018; Browne et al., 2011], which may contain up to 80-90 % of the microplastic initial content, although this exact figure varies across studies and locations.

[4] https://www.greenpeace.org.uk/press-releases/big-loopholes-tiny-microbeads-governments-proposed-ban-20170208/
[5] http://www.eunomia.co.uk/report-tag/microplastics/

It is possible to consider risk based on the relative amounts of microplastic in rinse-off and leave-on categories. The presence of microplastic in domestic products on the UK market (as noted in the original Defra request for comment) is assumed to be negligible and to constitute a tiny proportion of the total amount of microplastic released into the environment. According to [EC 2017], of the 16 million tonnes of soaps, detergents and maintenance products sold each year in the EU, around 0.03% contain microplastic, resulting in 190-200 tonnes of microplastic being discharged into the environment every year. Microplastic containing products include hard ceramic, toilet, stainless steel and oven cleaners and laundry stain removers. Of these, the vast majority of the microplastic is found in the hard ceramic cleaners which contain on average 4.9% w/w of polyurethane with particle sizes of below 600μm, accounting for some 126 tonnes of discharged microplastic.

The percentage of microplastic in leave-on products is also reported to be small in comparison to the total, contributing 2% of the total microplastic in cosmetic and personal care products compared to 98% in rinse-off products [CTPA, 2018]. Since cosmetics are estimated to contribute 0.01-4% of the total microplastic load in the ocean, the proportion attributable to leave-on products would then be 2% of that figure, or 2 x 10-4 – 8 x 10-2 % of the total.

According to these figures, the contribution made by microplastic in domestic cleaning products and leave–on products to the overall impact of microplastic in the marine environment is small. There is however, no scientific basis for treating them separately.

Ecological harm posed by microplastics

Comprehensive evidence of the potential for microplastic to cause ecological harm to oceans and to the food supply remains limited in this emerging area of science and the negative impacts are not yet fully established [SAPEA, 2019, Burns and Boxall, 2018]. New empirical studies describing exposure and effects are appearing rapidly [e.g. Wen et al., 2018, Karami et al., 2017;]. An emerging paradigm describes a suite of negative biological effects including inflammation, disruption to feeding activity and energy assimilation with knock-on effects for growth and reproduction [Galloway et al., 2017, Revel et al., 2018]. Many of the studies describing these effects have been performed in the laboratory at relatively high concentrations of microplastic and there are considerable knowledge gaps around dose-response and how these effects translate to ecological conditions [Wright and Kelly 2017].

We do not currently know enough about levels of environmental contamination to conduct a sound exposure assessment. There is in addition a considerable lack of data on the concentrations of plastic particles <100μm (and into the nanoscale) due to the technical challenges of accurately measuring this size range in natural waters and solid matrices. Given the exponential increase in plastic production, it is not known when or if toxicologically relevant concentrations of micro and nanoplastic will be reached in future [Backhaus and Wagner, 2018].

Nanoplastic poses an enhanced toxicological risk because the high surface area to size ratio allows for sorption of substances from the water column whilst its small size allows for passage across membranes and entry into cells and tissues with unknown ecological and health consequences [da Costa et al., 2016, Galloway et al., 2017]. [Hernandez et al., 2017] reported the presence of nanoplastic in microbead face scrubs, as a by-product of the manufacturing of microbeads. This illustrates the need to reconsider and update legislation on a regular basis as technology and analytical methods improve.

The relative dearth of scientific data on the toxicological hazard of micro and nanoplastic is not a reason to allow its continued emission into the environment. The absence of conclusive evidence for harm is not the same as the absence of harm. There are no studies reporting any benefits of microplastic in the environment and the unregulated release of any persistent substance into the environment in high amounts goes against all recommendations for environmental safety.

Other ingredients in leave-on cosmetic products

The relative proportion of the market taken up by rinse-off versus leave-on products was estimated to be 1530 million units of product sold in the UK (55%) to 1265 million units (45%) in 2017 [data prepared by CTPA, 2018], (CTPA could not readily convert this data in tonnage), with additional input from other personal care leave-on substances (disinfectants, insect repellents, dietary supplements). The microplastic content of these products is small compared with rinse-off products, but it is pertinent to consider that rinse-off products contain many other ingredients, including polymeric ingredients and other active substances into the environment and that they are used in relatively large quantities (e.g. compared with pharmaceuticals) and by all age groups throughout life. Because they are applied externally, they are not subject to metabolic transformation and may be introduced unaltered into the environment during washing, showering, and bathing [Ternes, 2004].

A research gap remains concerning the fate and environmental toxicity of leave-on cosmetics and personal care products in general, and the effectiveness of wastewater treatment works in removing active ingredients e.g. synthetic musks [Carballa et al., 2004], perfluoroalkyls compounds [Camp, 2014], some organic UV-filters [Ramos et al., 2016] in addition to microplastic [Browne et al.,2009].

Corporate responses

A concern with the whole question of rinse-off and leave-on products being inherently different is that the argument is driven less by a realistic need to assess their contribution to ecological harm and more by corporations seeking to find legislative loopholes, arguing for an increasingly narrow definition of what constitutes a microbead, for example [Dauvergne, 2017, Park, 2016].

There has been much debate around the role of corporate social responsibility and its role in shifting global environmental governance towards bottom-up and voluntary business initiatives, market mechanisms, eco-consumerism and consumer decisions [Cutler and Dietz 2017, Landon-Lane 2018]. When applied to the governance of plastic pollution, this approach has to date led to governance that is particularly uneven and uncoordinated across political jurisdictions, products and corporations [Dauvergne, 2018]. There have been calls for better international agreements to provide a framework for such governance, and these would no doubt help in setting firmer boundaries and greater debate over issues of definition (such as the questions posed here), harmonisation of techniques and methods and better exposure assessments.

Conclusions

What evidence is there that microplastics found in leave-on cosmetic and domestic cleaning products have an impact on the marine environment? Is this impact significant? How reliable is this evidence?

- Both leave-on and rinse-off products reach the marine environment through various pathways, and it is not currently possible to distinguish between them post discharge.
- Regardless of the wastewater treatment method used, a proportion of microplastic will end up in the environment, with the potential to cause harm.
- There is no scientific reason to treat microplastic from leave-on separately from rinse-off products. The release of microbeads from either source into the environment should be restricted on the basis of their persistence and potential to cause toxicological harm.
- The relative contribution of leave-on products to the overall risk posed by microbeads is in proportion to their fractional contribution to the total amount of microplastic released to the environment.
- There may be special arguments concerning genuinely essential uses of microplastic in cosmetics for which alternative substances are not currently available, such arguments should be scrutinised with reference to corporate social responsibility.
- The fact that microbeads are not the largest contributor to microplastic pollution should encourage policy concern in targeting other sources of plastic contamination and its underlying causes.

The relative dearth of scientific data on the toxicological hazard of micro and nanoplastic is not a reason to allow its continued emission into the environment. There are no studies reporting any benefits of microplastic in the environment and the unregulated release of any persistent substance into the environment in high amounts goes against all recommendations for environmental safety.

Competing interests

The lead author has declared no competing interests.

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