SafeFish Overview: Micro Plastics in Seafood

What is the Issue?

Since 2006, plastic use and production has increased exponentially all over the world with an estimated 250-300 million tonnes being produced annually (Castillo et al., 2016). With such a large amount of plastic being used, the amount of plastic pollutants ending up in the marine environment is also increasing at an alarming rate. Environmental activists have long highlighted the issue of plastic debris affecting marine ecosystems and animals, however only recently has the threat of microplastics been highlighted as a major concern. There is currently no internationally recognized definition of microplastics, however the EFSA panel report in 2016, defines them as a heterogeneous mixture of differently shaped materials referred to as fragments, fibers, spheroids, granules, pellets, flakes or beads in the range of 0.1-5,000 µm. A distinction has however been made by classifying them into two categories, primary, which are plastics manufactured to be of a microscopic size (typically used in facial-cleansers, cosmetics, as air-blasting scrubbers to clean surfaces, plastic powders used in moulding, or as vectors for drugs in medicines) and secondary, tiny plastic fragments derived from the breakdown through prolonged ultraviolet (UV) light exposure of larger plastic debris both at sea and on land (Cole et al., 2011; EFSA Panel Report, 2016; Ling et al., 2017). In addition to microplastics, researchers are also concerned that nanoplastics are being produced from the degradation, fragmentation and weathering of microplastic debris. This is of particular concern due to the nanoscale size of these particles (0.001-0.1 µm) and given that it is recognized that microplastics with a size <1.5 µm have the ability to translocate across the gut epithelium causing systemic exposure (Bouwmeester et al., 2009; EFSA Panel Report, 2016).

With the increasing focus on microplastics in the marine environment, a number of studies have shown that the inspection of gut contents of marine invertebrates such as pelagic fishes, estuarine crustaceans, shrimp and bivalves have shown the ingestion of microplastics as they are similar in size to some species of plankton. Microplastics have also been shown to accumulate in sediment and may therefore be available to benthic species, indicating that contamination with microplastics is commonplace throughout marine ecosystem (EFSA panel report, 2016; Ling et al., 2017). The risk of ingestion of microplastics by humans through eating contaminated seafood has been shown to be low as in most cases the product is eaten cleaned (with the gastrointestinal (GI) track removed). There is a higher risk from mussels, oysters and animals eaten whole or with GI track still intact however, the EFSA panel report has suggested that after oral ingestion, the largest fraction (>90%) of the ingested micro- and nanoplastics will be excreted via faeces. Only particles smaller than 150 µm may cause systemic exposure by translocating across the gut epithelium and further research into this is required. Another area of potential concern for human exposure to microplastics, is the fact that these particles readily absorb other potential cancer forming chemicals from the environment such as polychlorinated bisphenyls (PCBs), dioxins, persistant organic pollutants (POPs), heavy metals, polycyclic aromatic hydrocarbons (PAHs), bisphenyl A, phthalates, and polybrominated diphenyl esters (PBDE) (Andrady, A 2011; Cole et al, 2011; EFSA Panel Report 2016).

There are still a number of knowledge gaps that exist in relation to micro/nanoplastics and further research is required to understand their impact and effects more thoroughly. These gaps are as follows:

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- It is unknown what the effects of food processing has on the levels of micro/nanoplastics (the process may bring about a reduction in levels or depending on the technique it may even cause an increase in the amount present in the food).
- There is currently no research on human toxicokinetic factors or toxicity (including local effects in the GI) and incidence of degradation insitu of microplastics to nanoplastics.
- Currently methods of detection for microplastics are available but none for nanoplastics.

What is happening Internationally?

The European Union has a marine strategy framework directive (2008/56/EC) which aims to achieve Good Environmental Status (GES) of marine waters in the EU by 2020, however there is currently no specific legislation for micro- and nanoplastics as contaminants in food. The European Commission is also currently considering a target to reduce marine litter by 50% by 2030 as part of its circular economy package however this has not yet been passed formally. In 2015, the United States passed a 'Microbead Free Waters' act to ban rinse off cosmetics that contain intentionally added plastic microbeads (to be implemented from 1 Jan 2018) and to ban manufacturing of these cosmetics by July 1 2017.

What are the risks and impacts for Australia?

Detection of microplastic pollution of seafloor widespread along Australian SE coast

Researchers from IMAS and the University of Tasmania have recently identified the prevalence of microplastic contamination in the sediment along the coast of South Eastern Australia. They studied samples from 42 locations along the SE coast from Adelaide to Sydney and found forms of microplastic in every sample collected (on average there was 3.4 microplastics per mL of marine sediment collected). The highest average abundance of total microplastics per mL sediment was found in South Australian samples, whereas the lowest mean was detected in Tasmania. Interestingly however, the highest individual sample with the highest overall concentration was detected in Bicheno a small Tasmanian township with an active fishing fleet. It was determined that the microplastics from this sample were dominated by what appeared to be plastic rope fibers, a material used heavily in maritime activities. The detection of a ubiquitous distribution of microplastics in costal marine sediments has lead the researchers to support the recent ban on the use of plastic microbeads implemented by the Minister for Environment in 2016 detailed below (Ling et al., 2017).

Microplastic contamination in Oysters leading to reproduction and nutritional issues

A number of international studies have shown the ability of shellfish to take up microplastic through ingestion which poses a risk to human health, however a recent study has also shown that the contamination can cause issues to the shellfish itself. The study has indicated that in farmed oysters there may be a disruption to reproductivity (as the movement of sperm and the development of offspring are affected) as well as issues to the endocrine system and digestive system which in turn affects nutritional uptake. Given the detection of microplastics in the marine environment along the

SE coast of Australia, this could potentially cause issues for the Australian oyster industry (Pitman, S. 2016 News Article).

Australian legislation and Safefish Action

On the 29th February 2016 the Minister for Environment stated that the Federal Government will take action to implement a ban on plastic microbeads, if by 1 July 2017, it is clear that the industry voluntary phase-out has not been effective (Department of the Environment and Energy, 2016)). Given that this issue is gaining momentum internationally, further research in the area is imminent. This, as well as the fact that there are potential ramifications and effects for the Australian Seafood Industry, it is proposed that a watching brief by the SafeFish partnership is implemented. SafeFish should contact IMAS researchers and note our interest in this area, with potential for future collaboration when opportunities arise.

References

1. Alexander, J., Barregard, L., Bignami, M., Ceccatelli, S., Cottrill, B., Dinovi, M., Edler, L., Grasl-Fraupp, B., Hogstrand, C., Hoogenboom, L., Knutsen, H K., Nebbia, C S., Oswald, I., Petersen, A., Rogiers, V M., Rose, M., Roudot, A C., Schwerdtle, T., Vleminckx, C., Vollmer, G. and Wallace, H. (2016) Presence of microplastics and nanoplastics in food, with particular focus on seafood. EFSA Panel Report prepared for German Federal Institute for Risk Assessment (BfR). EFSA Journal 2016;14(6):4501.
2. Andrady, A L. (2011) Microplastics in the marine environment. Marine Pollution Bulletin, 62, 1596-1605.
3. Bouwmeester, H., Dekkers, S., Noordam, M Y., Hagens, W I., Bulder, A S., Heer, C., ten Voorde, S., Wijnhoven, S. and Marvin, H. (2009) Review of health safety aspects of nanotechnology in food production. Regulatory Toxicology and Pharmacology, 53, 52-62.
4. Castillo, A B., Al-Maslamani, I., and Obbard, J P. (2016). Prevalence of microplastics in the marine waters of Qatar. Marine Pollution Bulletin, 111, 260-267.
5. Cole, M., Lindeque, P., Halsband, C. and Galloway, T. (2011) Microplastics as contaminants in the marine environment: A review. Marine Pollution Bulletin 62, 2588-2597.
6. Department of the Environment and Energy (2016) 2016-17 Product List for the 2011 Product Stewardship Act. Accessed online (21/07/2017): http://www.environment.gov.au/protection/national-waste-policy/product-stewardship/legislation/product-list-2016-17
7. Ling, S D., Sinclair, M., Levi, C J., Reeves, S E., and Edgar, G J. (2017) Ubiquity of microplastics in costal seafloor sediments. Marine Pollution Bulletin, 121, 104-110.
8. Pigram, S. (2017) Microplastic pollution of seafloor widespread along Australia's south-east coast, study finds. News article accessed online (20/07/2017): http://www.abc.net.au/news/2017-07-14/plastic-waste-on-east-coast-seafloor-mapped/8706302
9. Pitman, S. (2016) New research points to impact of microplastics on oyster farming. News article accessed online (21/07/2017): http://www.cosmeticsdesign.com/Regulation-Safety/New-research-points-to-impact-of-microplastics-on-oyster-farming