Aquatic contamination with nanoplastics: potential risks to fish in River Minho

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Extended abstract

Despite the efforts to promote sustainable use of natural resources and waste recycling, the continuous production of plastics yearly and their long environmental persistence is leading to the increase of plastic debris in natural habitats. Therefore, in this work, we aim to review the existing data on this topic, identifying the sources of plastic (inc. micro and nanoplastics) in the river Minho watershed, highlighting the main risks to biota – fish in particular, and identifying knowledge gaps related to ecotoxicology research.

The risk of urban contamination of plastics is relatively low along the River Minho watershed, since high-density areas are inexistent on the banks and urban wastewater treatment facilities and waste landfills support human presence. Nevertheless, other identified pressures, including growing industrial "hotspots", emerging residential areas, and other local sources of contamination (e.g. urban runoffs, airborne particles, discharge of untreated effluents or wastes), can promote the increase of plastic debris and smaller fragments in river Minho and its tributaries.

Most studies with aquatic vertebrates and the ecotoxicological effects of nanoplastics use *Danio rerio* as model organism. The use of saltwater or brackish fish is also uncommon. Most of these studies focus on polystyrene effects – one of the most frequent types of plastic debris. However, the effects of nanoplastic fibres (and "fibrils") and other products derived from polystyrene textiles, which have also a very high environmental presence, are still poorly studied.

In addition to physical gastric blockages or internal cuts and bleeding caused by plastic debris ingestion, the smaller fragments - in micro and nanometer ranges, can cause microbiome alterations in the fish intestine. This is indeed one of the most relevant effects on fish, which promotes inflammation and decreased resistance to infections. Besides, nanoplastics can penetrate organisms' cell membranes and interact with biomolecules. Once inside, they can bioaccumulate in several organs. While in contact with the central nervous system cells, nanoplastics can induce neurotoxicity, leading to behavioural alterations in swimming/locomotion and memory. Bioaccumulation and structural alterations of several organs functioning (e.g.: liver, kidney, or gill),

oxidative stress and DNA damage have also been reported. The decrease of fish nutritional quality in fish exposed to nanoplastics and its presence in edible tissues of commercial fish (which can afterwards be ingested by the consumers) is also of relevance.

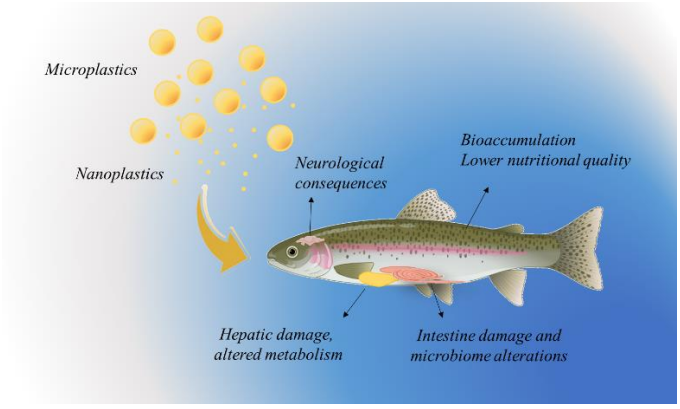

Fig. 1. Reported consequences of microplastics and nanoplastics to fish.

In some conditions, fish seem to be able to excrete previously ingested nanoplastics; however, these nanocontaminants can act as vectors – or "Trojan horses" for other environmental contaminants, such as metals, pesticides or endocrine disruptors, facilitating their cellular entrance, and promoting additional and long term toxicity to fish.

Nevertheless, it is worth mentioning that the biological effects of nanoplastics can vary based on the type of nanoplastics, their average size and concentration, and exposure duration. Besides, those effects can change depending on fish species or their development stage.

Plastic debris can, therefore, induce a range of harmful effects in fish, and their environmental presence potentially threatens all organisms along the trophic chains, including human consumers. Therefore, adequate management measures and policy implementation to prevent their occurrence in natural ecosystems - such as the River Minho watershed, are critical.

Keywords: bioaccumulation, *Danio rerio*, microbiome, nanoplastic, nutritional quality, polyethylene, polystyrene.

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