RESEARCH ARTICLE **(Open Access)**

Assessment of the Presence of Microplastics in Fish

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Abstract

The prevalence of microplastics in aquatic environments has raised concerns about their availability and risks to aquatic biota. Monitoring the ingestion of microplastics by fish in the environment is essential to understanding the risks that microplastics pose to the marine ecosystem. Since fish is an important source of animal protein for human beings, the occurrence and potential impacts of microplastics in fish deserve special attention. In this study, we investigated the ingestion of microplastics in 2 species of fish (30 samples of *Spaurus aurata* and 30 *Dicentrarchus labrax*) in the area of the Gulf of Vlora. The presence of microplastics was verified in 21.7 % of fish (9 in the stomach and 4 in the intestine). Fibers represented the largest amount of microplastics found, and the colors were mainly blue and black. Our results provided useful information for the assessment of the environmental risks posed by microplastics in the Vlora Bay area, from the perspective of marine organisms. Based on the literature, it can be concluded that microplastic pollution can occur in almost all types of aquatic habitats around the globe. Both field and laboratory studies suggest that fish are highly susceptible to ingesting microplastics.

Keywords: microplastics; aquatic environments; *Spaurus aurata; Dicentrarchus labrax*

1. Introduction

Plastics have been found worldwide in the marine environment, with estimates pointing to > 5 trillion plastic debris (over 250,000 tons) afloat at sea [8]. Based on size, plastics can be classified into five major categories: “nanoplastic” (<0.03 cm), “microplastic” (<0.5 cm), “mesoplastic” (0.5–5 cm), “macroplastic” (5–50 cm), and “megaplastic” (>50 cm) [12], [14]. A considerable amount of such plastic debris comes from continental sources entering the marine environment mainly through rivers [12], industrial and urban effluents, and runoff of beach sediments and neighbor fields. The other part results from direct inputs, such as offshore industrial activities (e.g. oil and gas extraction, aquaculture), loss of nets in fisheries and litter released during sea activities, including tourism.

Among plastic litter, microplastics are of special concern regarding the environment as well as animal and human health mainly due to their small size, the lack of technology available to quantify the presence of the smallest microplastics in the environment, and their potential to cause adverse effects on the marine biota and humans.

Microplastics have been defined as small pieces of plastic less than five millimeters in size with no lower limit established [10]. The microplastics present in the marine environment result from the fragmentation of larger plastic debris or may be introduced into the water and sediments already as micro- or nano-sized particles. Examples of microplastics are pre-production pellets and components of diverse products, such as fragments of fishing gear, packages and drink bottles, synthetic textiles, car tyres, paints, cosmetics and personal care products (e.g. facial cleaners, bath gels, toothpaste), and electronic equipment among others [9], [2], [10].

Consequently, microplastics encompass a very heterogeneous assemblage of particles that vary in size, shape, and chemical composition, among other properties [3]. The increased incidence of plastics in various compartments of the aquatic environment has been associated with human population density, highlighting a direct relationship between human

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(Accepted for publication 6.05.2023)
***ISSN**: 2218-2020,*

population increase and plastic pollution [7], [11] accumulating in different marine ecosystems at increasing rate [4], [15].

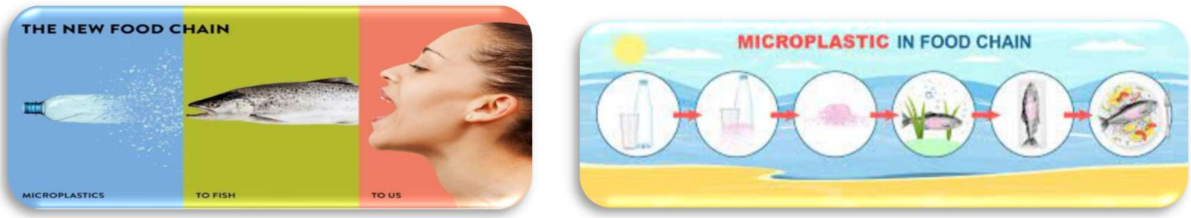


Figure 1. Microplastic in food chain

The contamination of oceans by microplastics is of concern not only because of the ecological impacts but also because they may compromise food security and consequently human health. The presence of microplastics in species used for human consumption is a global problem and we are vulnerable to microplastic exposure through the consumption of seafood and other human food items, as well as through other routes such as air. Nevertheless, information on the occurrence of microplastics in these products is scarce, the exposure levels are in general largely unknown, and the potential effects on consumers are poorly understood [13].

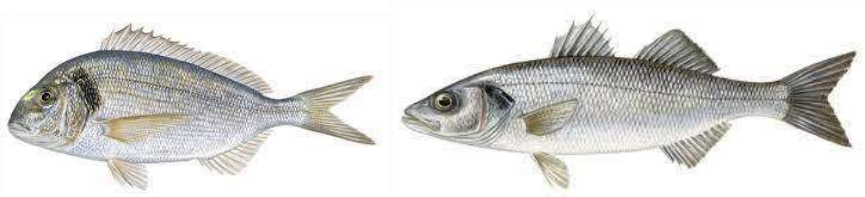
This information is necessary for providing a basis for a sound risk assessment. Understanding the processes and mechanisms involved in the entry and assimilation of microplastics in human tissues and their potential effects on human health is a priority research area and should be explored in the coming years.

2. Material and Methods

2.1. Study area and collection of fish samples

The study was carried out on fish samples collected in the Gulf of Vlora. In recent years, this city is populated even more, especially during the summer season, and as a result marine pollution with solid waste has increased. Small-scale artisanal fishing activity is also evident in this region. During the months of July-August 2019, two species of fish very useful to Albanian consumers were collected: Spaurus aurata (n=30) and Dicentrarchus labrax (n=30).

The samples were placed in a cooler with ice immediately after capture and transported to the laboratory. Information related to: fishing location, date of catch and depth was recorded. In the laboratory, fish samples were stored at -20 °C until its analytical testing.



Spaurus aurata *Dicentrarchus labrax*

Figure 2. The types of fish sampled

2.2 Detection of microplastic particles in the gastrointestinal tract.

Fish samples were taken out of the freezer, thawed, and 0.1 g of each individual was weighed and measured for total length to the nearest 0.1 cm. The intestines and stomach were dissected and placed in a 250 ml glass beaker. To dissolve the organic matter, 25 mL of sodium hydroxide (NaOH, 1 mol L−1) was added to the beaker and heated to 50 °C on a hot plate for 15 min with continuous stirring. Each sample was diluted with 125 ml of bidistilled water and vacuum filtered (0.2 µm pore size) and vacuum passed through a 300 µm gauze. The recovered microplastic particles were examined under a dissecting microscope (Zeiss, magnification 8−50x) and their number, color and polymer type were observed. The prevalence of microplastics

(percentages of fish where the presence of microplastics was observed) was calculated.

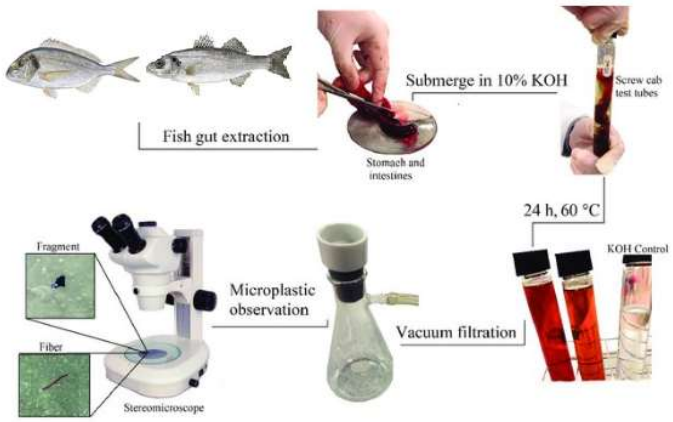


Figure 2. Procedural steps for extracting microplastics from fish guts (according to DE-LA-TORRE, G.E. et. al.)

3. Results and Discussion

The presence of microplastics was verified in 21.7 % of the total fish samples tested. The results by species for the presence of microplastics in the intestine and stomach are given in Table 1. Threads represented the largest amount of microplastics found, and the colors were mainly blue and black. Our results provided useful information for the assessment of environmental risks caused by microplastics in the Vlora Bay area, from the perspective of marine organism

Table 1. Results for the presence of microplastics in the intestine and stomach

Species selected for study	Nr. of analyzed samples	Microplastic		%
		Stomach	Intestine	
Spaurus aurata	30	4	2	20
Dicentrarchus labrax	30	5	2	23,4
Total	**60**	**9**	**4**	**21,7**

These results prove that in fish caught in this area the risk of high concentrations of plastic waste, populations can be negatively affected. Also, these fish species may decline over time, with potentially negative consequences for environmental health, biodiversity conservation, ecosystem services, and human food security (availability for the human population).

Thus, to properly assess and manage risks, more studies on the effects of microplastics are needed, with a particular focus on the long-term effects caused by exposure to ecologically relevant concentrations of microplastics commonly found in the environment.

Various studies prove that, however, removing the gastrointestinal tract of fish may not completely prevent the ingestion of microplastics, as some particles have been detected in the edible muscle tissues of fish, squid, crab and shrimp [1], [5], [6]. These results suggest that considering the digestive tract as the sole reservoir of plastic may lead to an underestimation of the actual amount that can be ingested.

4. Conclusions

Plastic fragments tend to accumulate in biota and their quantification and characterization in the digestive tracts of marine organisms indirectly reflect their occurrence in the aquatic environment. The challenges and knowledge gaps related to microplastics and the implications for food safety and health are undoubtedly current worldwide. Also in Albania it is necessary to take into consideration the facts and results of various studies.

As microplastic concentrations are expected to increase in the future, it will be increasingly important to regularly assess microplastic levels in seafood and other food items [7]. It is also important to quantify the presence of microplastics in edible tissues of fish and shellfish, establishing continuous monitoring programs to assess the presence of microplastics in environmental compartments and thus to avoid the reduction of global stocks of fish and shellfish.

Research should also focus on the chemical and microbiological hazards and risks associated with ingested microplastics and in improving methods to assess the uptake and translocation of these particles in humans. It is important to adopt food safety risk analysis frameworks to assess the risks and hazards to consumers of fish, shellfish and food items contaminated with microplastics.

There is a great need to study the assimilation of a variety of sizes and compositions of microplastics in human tissues and in development of techniques capable of identifying the presence of microplastics in the human body (eg biopsies and tissue banks).

Another area that deserves urgent attention is the presence of nano-sized plastics in seafood for which there is even less data in the literature. Research on the analytical methods, toxicokinetics and toxicity of micro- and nano-sized plastics is needed to improve understanding of their potential impacts on seafood safety and human health.

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