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RESEARCH ARTICLE

Occurrence of microplastics in the gastrointestinal tracts of four most consumed fish species in Giresun, the Southeastern Black Sea

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Abstract

Microplastic studies investigating concentrations in water are numerous, but the majority of microplastics settle and are retained in sediment, and higher concentrations are regularly reported in sediments. Thus, MPs accumulation may be more threatening to benthic fish living in sediments than to pelagic fish. The presence, abundance and diversity of microplastics were investigated by collecting samples from two pelagic, European anchovy, and horse mackerel and two benthic fish species, red mullet, and whiting that are popularly consumed in Giresun province of Türkiye, located on the southern coast of the Black Sea. Visual classification and chemical compositions of microplastics was performed using a light microscope and ATR-FTIR spectrophotometry, consecutively. The overall incidence and mean microplastics abundance in sampled fishes were 17 and 1.7 ± 0.18 MP fish^{-1}, respectively. MPs were within the range of 0.026–5 mm in size. In most of the cases, the MP was black in color with 41%. With the rates of 56%, polypropylene was the predominant polymer type. The most dominant MP type was identified as fiber followed by fragments and pellets. The relationship between MP amounts in fish and Fulton condition factor was not strong enough to establish a cause-effect relationship.

Keywords ATR-FTIR spectroscopy · Black Sea · *Engraulis encrasicolus* · Fulton condition · Microplastics · Polyethylene

Introduction

Microplastics (MPs) are widespread environmental pollutants that are ubiquitous in all ecosystems, including marine ones. In addition to the primary MPs produced deliberately, as in cosmetic products, secondary MPs also occurs in marine ecosystems as a result of the mechanical, photochemical, and biological degradation of plastic products (Prata et al. 2020; Sadia et al. 2024). As studies showing the presence of microplastics in different tissues of the human body increase day by day, their presence in the foods we consume becomes a matter of curiosity (Demirelli et al. 2024). Marine fish, Marine fish, one of the most popular human foods, are in constant interaction with MPs in their environment. Accumulation of MPs in commercial fish worldwide has been the focus of attention as much as accumulation of heavy metals (Ali et al. 2022, 2024; Islam et al. 2022). MPs detected especially in commonly consumed fish species is closely monitored as it poses a threat to public health (Haque et al. 2023; Khaleel et al. 2023; Quilis et al. 2024; Srisiri et al. 2024).

MPs have been detected in many marine creatures, including fish, in various shapes, colors and sizes. Fiber-type MPs transmitted from clothing and fishing nets is common in marine environments (Cole et al. 2011). The density of MP affects its vertical distribution in seawater, and due to their lower density, polyethylene (PE) and polypropylene (PP) predominate in the upper layers in seawater (Prata et al. 2020). MP accumulation in planktivorous fish including European anchovy (*Engraulis encrasicolus*) are more worrying because plankton sizes are similar to those of MPs. On the other hand, benthic species including red mullet (*Mullus barbatus*), and whiting (*Merlangius merlangus*) feed on small benthic organisms. Due to this different feeding behavior between species and the different distribution of MPs in these environments, both qualitative and quantitative differences in the digestion of MPs are expected.

Studies investigating MP formation in aquatic organisms have been carried out comprehensively following the

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establishment of the Marine Strategy Framework Directive in June 2008 with the aim of protecting the marine environment across Europe. Past studies have pointed to Türkiye, Russia and Bulgaria as the top emitters of plastic due to vast load of waste from major rivers and major urban areas (Savuca et al. 2022). Therefore, investigating the presence of microplastics in these hot spot regions is important in terms of creating the necessary legislation and conservation strategies for the protection and sustainability of marine ecosystems.

MPs in biota within Black Sea have been studied on copepods, bivalves, seahorse, and commercial fish species (Stienbarger et al. 2021; Aytan et al. 2022a; Gedik and Gozler 2022; Onay et al. 2023). However, data on the abundance of MPs in commercially important fish species in Giresun is limited and studies that address this knowledge gap are needed especially as it is a fishing city. While the per capita consumption of seafood in 2021 was 7 kg in Türkiye, this rate is reported to be 28 kg in Giresun, located on the Black Sea coast (TUIK 2021). For the current study, the four most consumed fish species were selected as target species, taking into account the fish consumption preferences of Giresun residents.

The aim of the current study was to evaluate and characterize the presence of MP in a total of four economically important fish species, two of which are pelagic and two of which are benthic, caught in Giresun province, located on the southern coast of the Black Sea. Moreover, MP ingestions will be compared between sampled species from pelagic and benthic habitats.

Materials and methods

Study area and fish sampling

Giresun, a fishing city, is a tourist attraction area with its only natural island located on the southeastern Black Sea coast. A very busy Black Sea international highway passes through the city along this 120 km coastline (Kodat and Tepe 2023). The city has a fishing port, an international port area, small-scale industries, two large rivers (Aksu and Pazarsuyu Rivers) and many streams. River plumes are common in the region as a result of heavy rainfall (Kostianoy et al. 2019). In summer, the uniquely beautiful beaches on its coast attract tourists from all over Türkiye. Aforementioned activities cause an increase in plastic bags, bottles, packaging films and other plastic-based marine wastes and accumulate in the marine environment (Fig. 1).

This study investigates the presence of MP in European anchovy (*Engraulis encrasicolus*), horse mackerel (*Trachurus trachurus*), red mullet (*Mullus barbatus*), and whiting (*Merlangius merlangus*) caught in Giresun, Türkiye, on the southeastern Black Sea coast. The four most commonly consumed fish species in the city, with different nutritional strategies and habitats, were selected for the study due to their high meat quality and taste. Country statistics revealed that the most caught fish was European anchovy with 151,598 tons, followed by horse mackerel with 19,590 tons in 2021 (TUIK 2021). These two favorite fish are pelagic species and represent the pelagic region. Contrary to these, the other two selected species were red mullet and whiting from the demersal species. Thus, the present study was carried out to examine the prevalence, properties and chemical composition

Fig. 1 Map of the study area with general view of Giresun

of microplastics in fishes habituated in different aquatic environments.

Fish samples were purchased from a fishing boat engaged in commercial fishing on the coast of Giresun city center. The average water depth of the fishermen's fishing area varies between 60 and 120 m. Sampling was performed on September 20, 2022 and fish samples were wrapped in aluminum foils and immediately transported to the university laboratory in + 4 °C ice packs. Fish samples transferred to the laboratory were kept in a deep freezer at – 20 °C until extraction process.

Analysis of microplastics

As an extraction method, Karami et al.'s protocol was followed with some modifications (Karami et al. 2017). All fish samples were thawed and placed on the operating table for dissection. Before dissection, the length and weight of the sampled fish were measured with a 0.01 mm precision digital compass, and 0.01 g precision balance, respectively. With the dissection process, the gastrointestinal tracts (GIT) of the sampled fishes were removed, weighed, and recorded together with their length (cm) and weight (g) (Table 1). For each of the GIT samples placed in glass flask, 50 ml of 10% potassium hydroxide (KOH) solution was added. Samples placed in glass flask were then incubated at 40 °C and shaken daily during the digestion procedure to speed up the digestion process. The suspension was sonicated at 50 Hz for 5 min and shaken at 200 rpm for 5 min. The suspension was centrifuged at 500xg for 5 min and the supernatant was collected and filtered by using the vacuum filtration unit through Whatman filter membrane. The filtrate was allowed to dry in a sealed glass petri dish and then analyzed for the presence of MP particles under a light microscope (Olympus CKX41) using 10 × objectives. The visible MPs were then photographed with a camera (Celestron) attached to the microscope. Data were expressed as “mean ± sem”.

Characterization of microplastics

On the captured images, MPs were first classified as pellets, films, fibers or fragments, and then the lengths of the particles were recorded. Visual classification of microplastics was made according to the following criteria: i) absence of organic or cellular structures; ii) the particles must have a constant thickness and iii) a consistent color throughout their overall length; iv) clear and white particles should be further validated to exclude an organic source. When in doubt, the "hot needle" test was used (De Witte et al. 2014).

Characterization of the chemical compositions of particles in GIT obtained from 40 fish was performed using ATR-FTIR spectrophotometry (Shimadzu IR Prestige-21). Three consecutive spectra were obtained per sample. The measurement range is 4000–400 cm^{-1} and background scans were made before each homogenized sample was scanned by making an average of 64 scans with a resolution of 4 cm^{-1} for each spectrum. All spectra were analyzed by Essential ATR-FTIR v3.50.205 (Operant LLC) software, providing data normalization and baseline correction. Spectrum match with a quality index > 75% was accepted for the presence of microplastics, then cross-checked with spectra from the literature. The most common polymers such as polyethylene (PE), polyamide (PA), polypropylene (PP), polyester (PES), polyvinyl chloride (PVC), polyethylene terephthalate (PET), polystyrene (PS), polyvinyl alcohol (PVA), acrylonitrile, butadiene styrene (ABS), nitrile, latex, polymethyl methacrylate (PMMA), polyurethane (PU), polyoxymethylene (POM) and polycarbonate (PC) were investigated. Spectra of distilled water were also taken to avoid possible plastic contamination through the extraction process.

Quality control

All fish samples were washed with distilled water before initiating the analysis to remove any plastic particles that might be on them. During the laboratory studies, protective equipment consisting of gloves and overalls apron was used to prevent possible plastic contamination from clothing and

Table 1 Characteristics of sampled fishes

	Trachurus trachurus	*Mullus barbatus*	*Engraulis encrasicolus*	*Merlangius merlangus*
Living habitat	Pelagic	Demersal	Pelagic	Demersal
Feeding type	Carnivore	Carnivore	Carnivore	Carnivore
Analyzed fish (N)	10	10	10	10
Length (cm)	12,21 ± 0,99	13,29 ± 0,98	10,38 ± 0,40	14,9 ± 1,1
Fresh weight (g)	16,66 ± 3,66	24,45 ± 5,21	7,70 ± 0,84	24,96 ± 5,62
GIT (g)	0,86 ± 0,25	1,12 ± 0,48	0,55 ± 0,10	1,89 ± 0,60
Total MPs	16	19	15	18
Mean MPs	1,6	1,9	1,5	1,8

air. Throughout the entire study, rigorous quality control and care were implemented to prevent cross contamination in all analyses processes including fish sampling, transport of sample fishes to the laboratory, preservation until extraction, addition of extraction solution, dissolution of organic fraction, filtration as well as identification of MP both under microscope and with ATR-FTIR spectrophotometer. Prior to extraction, all solutions, ethanol and HPLC grade distilled water were filtered through a 26 µm GF/F Whatman microfiber filter paper. All glassware and metal laboratory materials were washed and rinsed twice with HPLC grade distilled water and ethanol consecutively, and then dried in oven. Filtered filter papers are stored in autoclaved glass petri dishes until further analysis. Blank experiments were performed in triplicate with extraction solutions placed in empty tubes to identify possible cross-contamination of airborne microplastics in each analysis in the laboratory. These blank tubes were analyzed in parallel with the samples and no microplastics were detected in the blanks.

Results

A total of 40 stomach contents were analyzed to report the amount, characteristics, and chemical composition of the MPs ingested by both pelagic and benthic fish species. The overall frequency and mean MPs amount in sampled fishes were 17 and 1.7 ± 0.18 MP fish^{-1} (Table 1), respectively. The mean amount of MP in *Engraulis encrasicolus* was determined as 1.8 MP fish^{-1} in this study. The mean MP amount in *Trachurus trachurus*, the other pelagic species of this study, was found to be 1.6 MP fish^{-1}, close to anchovy. The average MP numbers in the benthic fish species of the study were found to be close to each other. The amount of mean MP in *Mullus barbatus* was found to be 1.9 MP fish^{-1}. A similar average MP amount was found to be 1.8 MP fish^{-1} in *Merlangius merlangus*.

The condition factor is an important variable that indicates whether any fish is adequately fed and healthy. On the other hand, the changes observed in the value of the condition factor primarily give clue about the gonad development and the degree of nutrition (Menéndez et al. 2023).

The Fulton's condition factor (K) of the fish species were calculated using the equation $K = (W/L^3)*100$ (Froese 2006). The K value were found to be in the range of 0.82–0.99 (mean 0.91) for *Trachurus trachurus*, 0.97–1.20 (mean 1.04) for *Mullus barbatus*, 0.62–0.72 (mean 0.69) for *Engraulis encrasicolus* and 0.60–0.89 (mean 0.75) for *Merlangius merlangus*.

The relationship between MP amounts in fish and K values demonstrated a low, statistically significant negative correlation for red mullet (rho = -0.062, p = 0.865, N = 10), and whiting (rho = -0.069, p = 0.849, N = 10), and low statistically significant correlation for European anchovy (rho = 0.317, p = 0.372, N = 10), horse mackerel (rho = 0.142, p = 0.695, N = 10) (Fig. 2).

For whiting and red mullet, a weak negative correlation between the presence of microplastics in GT and the K values was not strong enough to establish a cause-effect relationship.

Moreover, MPs were evaluated in terms of color, as presented in Table 2 and Fig. 3. Black was observed to be the dominant color and fiber type was the dominant type in MPs found in all fish samples. Among all extracted MPs, black was the most dominant color with 41%, followed by blue with 24%, red with 24% and green with 11%. The color distributions of MPs by fish samples are as follows. *Trachurus trachurus* had 38% black, 31% red, 25% blue and 6% green color. *Mullus barbatus* had 42% black, 26% blue, 21% red and 12% green color. *Engraulis encrasicolus* had 40% black, 33% blue, 20% red and 7% green color. *Merlangius merlangus* had 50% black, 22% red, 17% blue and 11% green color.

The most dominant MP type was identified as fiber followed by fragments and pellets. The distribution of MPs types on the basis of fish samples was determined as follows. *Trachurus trachurus* had 50% fiber, 30% fragments and 20% pellets; *Mullus barbatus* had 47% fiber, 37% fragments and 16% pellets; *Engraulis encrasicolus* had 60% fiber, 33% fragments and 7% pellets; *Merlangius merlangus* had 50% fiber, 39% fragments and 11% pellets as illustrated in Fig. 4. Percentage of microplastics found in fish species categorized by shape.

MPs were within the range of 0.026–5 mm in size. The size classes together with percentages of MPs recorded in sampled fish species are as follows; 0–0,5 mm (25%), 0,5–1 mm (25%), 1–2 mm (19%), 2–5 mm (31%) for *Trachurus trachurus;* 0–0,5 mm (21%), 0,5–1 mm (26%), 1–2 mm (26%), 2–5 mm (26%) for *Mullus barbatus;* 0–0,5 mm (13%), 0,5–1 mm (27%), 1–2 mm (33%), 2–5 mm (27%) for *Engraulis encrasicolus;* 0–0,5 mm (6%), 0,5–1 mm (28%), 1–2 mm (33%), 2–5 mm (33%) for *Merlangius merlangus*. The mean percentages of size classes of MPs recorded in all fish samples are as follows; 16% at 0–0,5 mm, 26% at 0,5–1 mm, 28% at 1–2 mm, 29% at 2–5 mm (Fig. 5).

One of the most widely used and effective techniques to determine the polymer type of microplastics is ATR-FTIR spectroscopy. ATR-FTIR can detect a polymer at a resolution of 10 µm. Samples can be reused after analysis and require few samples. However, it is not considered efficient as thick microplastics are easily detected while thin and small ones cannot be detected. The polymer of the unknown sample is determined by comparing its infrared spectra with a known one. Several spectral libraries are used for comparisons (Khan et al. 2022).

Three different polymer types named polypropylene (PP), polyamide (PA) (nylon) and polyester (PES) were identified

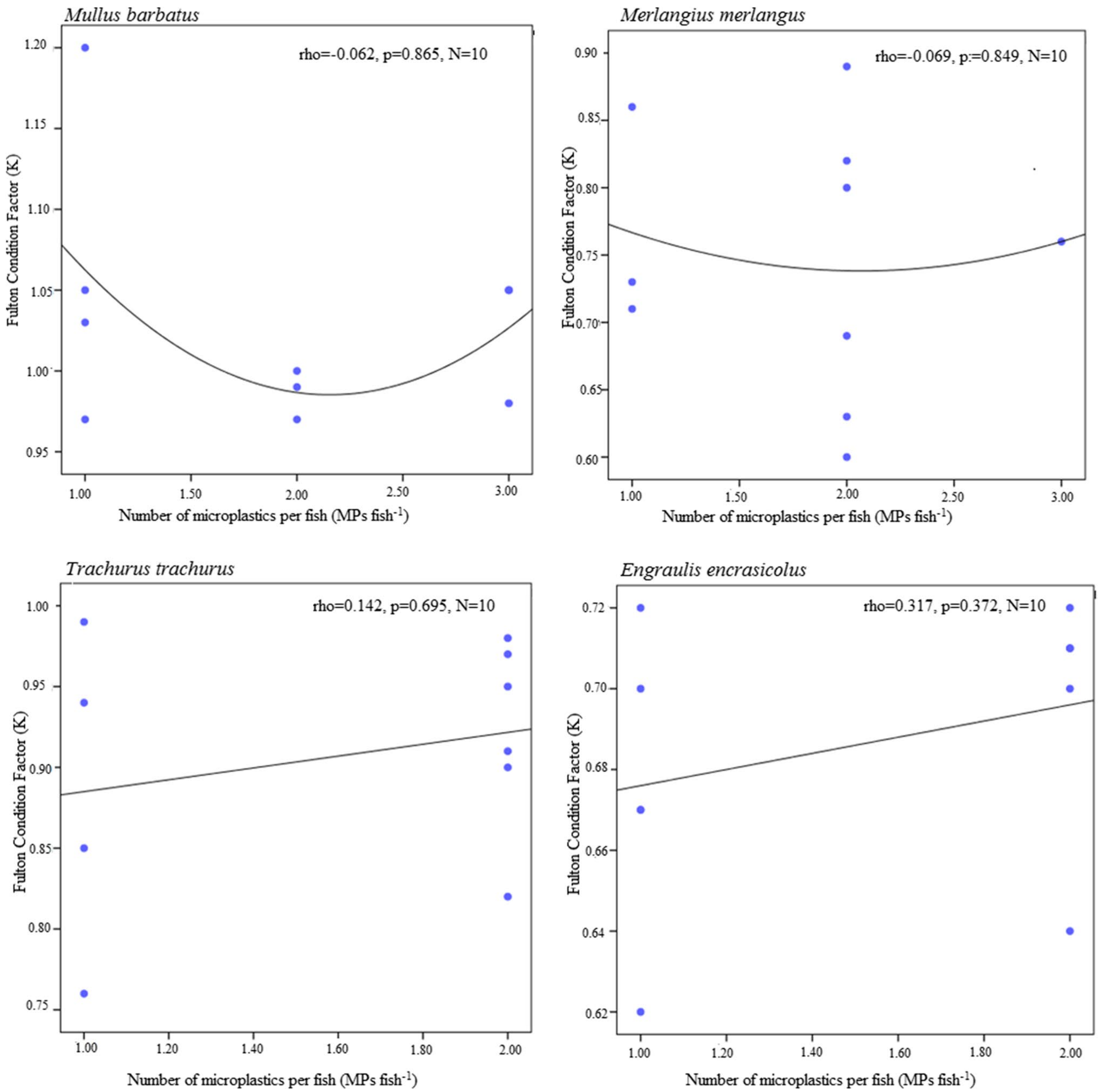

Fig. 2 Spearman Rank Correlation between MP amounts and K values in the GIT of *Mullus barbatus*, *Merlangius merlangus*, *Trachurus trachurus* and *Engraulis encrasicolus* on the coast of Giresun

among fish species with the rates of 56%, 25%, and 19%, respectively by FT-IR analysis performed in the present study (Fig. 6). Polymer types did not differentiate depending on whether the fish were demersal or pelagic.

Table 2 Comparison of the number, color and types of MPs reported from various places in the literature for the fish species in the current study

Species	Collection site	Mean number of MPs per fish	Dominant color	Predominant type	Reference
Trachurus trachurus	Black Sea (Giresun)	1.6	Black	Fiber	This study
Mullus barbatus	Black Sea (Giresun)	1.9	Black	Fiber	This study
Engraulis encrasicolus	Black Sea (Giresun)	1.5	Black	Fiber	This study
Merlangius merlangus	Black Sea (Giresun)	1.8	Black	Fiber	This study
Trachurus trachurus	Portugal	2.24	Blue	Fiber	Pequeno et al. 2021
Mullus barbatus	NE Mediterranean Sea	1.61	Blue	Fiber	Güven et al. 2017
Mullus barbatus	Black Sea	0.76	Black	Fiber	Atamanalp et al. 2021
Mullus barbatus	Southeastern Black Sea	1.59	Black	Fiber	Aytan et al. 2022b
Mullus barbatus	Northeastern Mediterranean	2.2	Black	Fiber	Gündoğdu et al. 2020
Mullus barbatus	Black Sea	0.40	-	Fiber	Eryaşar et al. 2022
Mullus barbatus	Northeastern Mediterranean	2.9	Black	Fiber	Kılıç and Yücel 2022
Engraulis encrasicolus	Black Sea	1.81	Black	Fiber	Aytan et al. 2022b
Engraulis encrasicolus	South Africa	1.13	-	Fiber	Bakir et al. 2020
Merlangius merlangus	Southeastern Black Sea	1.33	Black	Fiber	Aytan et al. 2022b
Merlangius merlangus	Black Sea	1	Blue	Fiber	Aytan et al. 2023

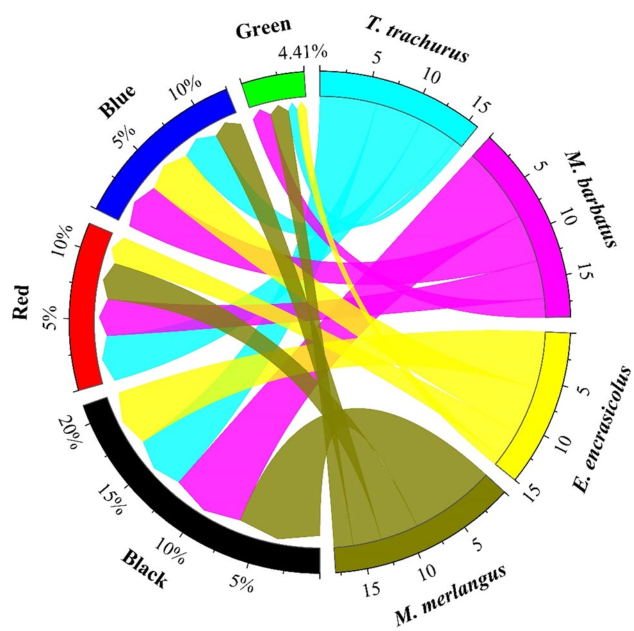

Fig. 3 Percentage of MPs extracted from fish species, sorted by color

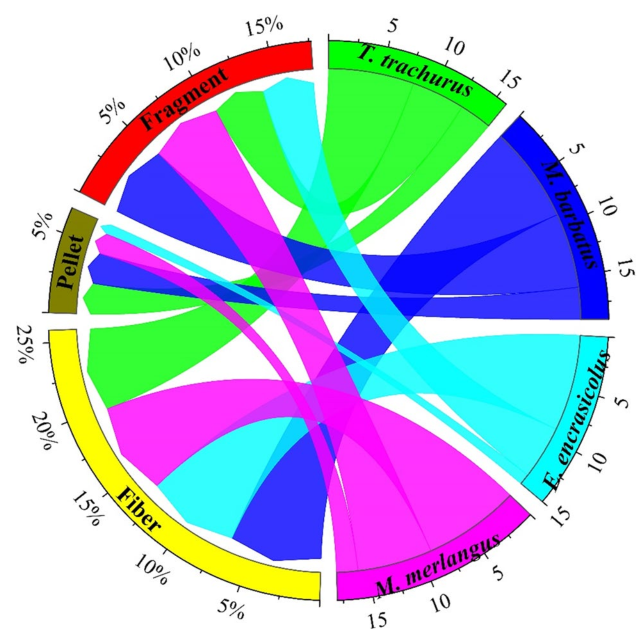

Fig. 4 Percentage of microplastics found in fish species categorized by shape

Discussion

In the current study, the presence of MP in four fish species, which are the most consumed fish in the city of Giresun, with a coastline of 120 km to the Black Sea, was examined. Moreover, the fish species selected in the study were chosen from two different habitats, demersal and pelagic, in order to make comparisons. However, it was noteworthy that the presence of MPs was detected in every species examined. The prevalence of microplastics in fish species from various regions of the world is presented in Table 2. The variability of microplastics observed in fish is mainly attributed to different habitats, pollution status, and different dietary habits of the studied species (Keerthika et al. 2023). The mean number of MP fish^{-1} (1.7) in the present study was similar to those reported from the Gulf of İzmit, Türkiye (1.77 MP fish^{-1}), and from the coast of Portuguese (0.30—2.46 MP fish^{-1}), lower than a study carried

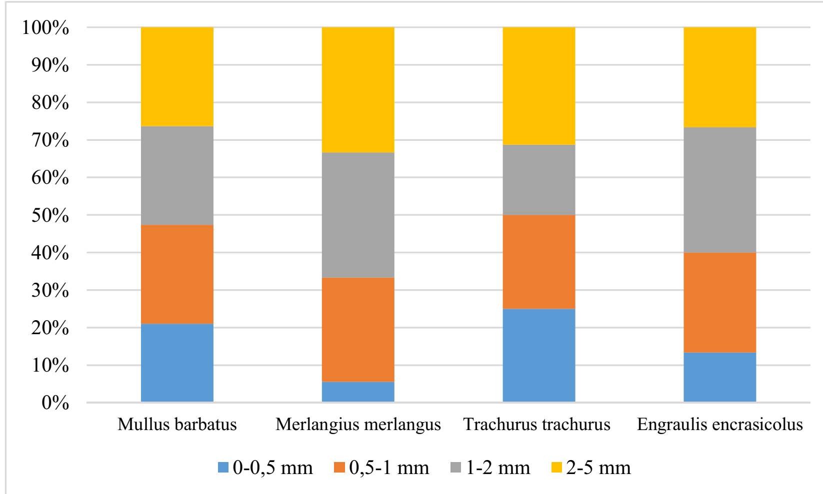

Fig. 5 Size range (in mm) of microplastics extracted from fish species

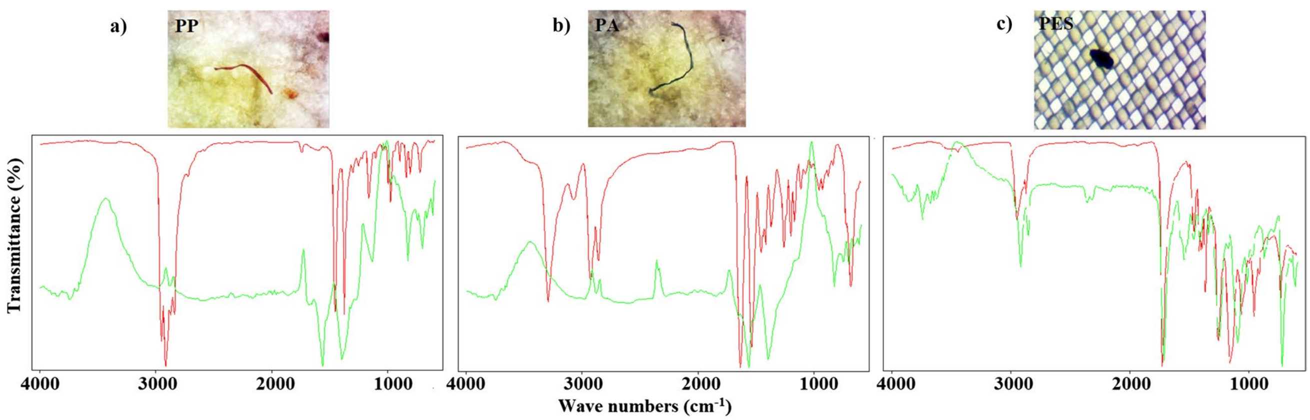

Fig. 6 Microscope images and ATR-FTIR spectrums of microplastics in the fish sampled in Giresun, Türkiye. **a**) PP: Polypropylene, **b**) PA: Polyamide, **c**) PES: Polyester

out along the NE Mediterrenean, in Samandağ (11.25 MP fish^{-1}) and İskenderun (4.22 MP fish^{-1}) and higher than a study run along the Thoothukudi coast, South Tamil Nadu, India (0.67 MP fish^{-1} for benthic and 0.53 MP fish^{-1} for pelagic fish species) (Pequeno et al. 2021; Kılıç and Yücel 2022; Aytan et al. 2023; Keerthika et al. 2023). In addition to the methodological differences among the studies, the observed differences in MPs are also influenced by fish ingestion, feeding behavior, habitat and migratory behavior of the species, nutrient availability and the concentration of ambient MPs in seawater, and the amount of sediment in the habitat of the fish (Aytan et al. 2023).

One of the species examined, European anchovy, is the most popular and most caught species not only in the city but in the whole country with 125,980 tons/year. Therefore, MP accumulation that may occur in European anchovies may be an important pathway of transferring plastics and related toxic chemicals to humans. This popular species has been previously studied in nearby areas, and higher (1.81 MP fish^{-1}) and lower (0.15 MP fish^{-1}) MP amounts were reported compared to the current study (1.80 MP fish^{-1}) (Aytan et al. 2022b; Eryaşar et al. 2022). Relatively high levels of MPs in European anchovy with 1.92 ± 0.95 MP fish^{-1} were reported in a study conducted in the NW Iberian shelf (Filgueiras et al. 2020). On the other hand, lower levels were recorded with the mean of 1.13 MP fish^{-1} from Africa (Bakir et al. 2020) (Table 2).

The amount of mean MP in *Trachurus trachurus* was found to be 1.6 MP fish^{-1} in the present study which was lower than that of from a study conducted in Portugal with 2.24 MP fish^{-1} (Pequeno et al. 2021). On the other hand, lower levels were recorded with the mean of 0.46 MP fish^{-1} from Atlantic coast (Maaghloud et al. 2021) (Table 2).

The amount of mean MP in *Mullus barbatus* was found to be 1.9 MP fish^{-1} in the present study similarly, it was 1.61

MP $fish^{-1}$ in a study reported from the NE Mediterranean Sea (Güven et al. 2017). Lower average amount of MP with 0.76 MP $fish^{-1}$ from a study conducted in the Black Sea (Atamanalp et al. 2021), and higher average of MP with 2.9 MP $fish^{-1}$ from a study conducted in the Mediterranean (Kılıç and Yücel 2022) were reported. Different sampling and analysis methods, as well as sampling time, sample size, weather, presence and distribution of MPs in the sampling area, fish behavior and habitats, can cause significant differences in the findings of recent studies (Eryaşar et al. 2022).

The amount of mean MP in *Merlangius merla*ngus was found to be 1.8 MP $fish^{-1}$ in the present study which was above the reported mean values of 1.33 MP $fish^{-1}$ and 1 MP $fish^{-1}$ from two recent studies in Black Sea and Galway Bay, respectively (Pagter et al. 2020; Aytan et al. 2022b). On the other hand, with the mean of 1.9 MP $fish^{-1}$, similar levels of MP were determined from the English Channel (Lusher et al. 2013).

As in most compared studies, the dominant color of MPs in this study was black with 41% (Table 2) (Gündoğdu et al. 2020; Atamanalp et al. 2021). Demersal fish may accidentally ingest black colored MPs as they barely visible on the deep seawater surface (Koongolla et al. 2022). It has been reported that the main reason why the demersal fish, which mostly graze on the sediments, consume more black MPs may be due to their similarity to their food (Ferreira et al. 2020; Atamanalp et al. 2021). It has been reported that young fish tend to consume black MPs particles because they resemble them as their food (Ferreira et al. 2020). Following black, red and blue were the second dominant colors, both with 24% ratios. In the studies conducted on the Atlantic coast, Mediterranean and the Black Sea, presented in Table 2, the color blue was reported to be dominant color (Güven et al. 2017; Maaghloud et al. 2021; Aytan et al. 2023). The predominant presence of blue and red colored MPs may be indicative of their presence in seawater in large quantities and their active ingestion.

Fiber was the most common type of MP in the current study, as in all studies compared worldwide in Table 2. The highest fiber content was in *Engraulis encrasicolus* with 82% and the lowest fiber content was in *Mullus barbatus* with 47%. Similarly, in studies conducted in South Africa, and the Gulf of Cádiz, the highest fiber content was reported in *Engraulis encrasicolus* with 82% and 93.3%, respectively (Bakir et al. 2020; Sánchez-Guerrero-Hernández et al. 2023). Fragmentation from fishing nets, textile industry, and washing machines are reported as the sources of the fibers (Browne et al. 2011; Andrady 2011; Hartline et al. 2016).

MPs were within the range of 0.026–5 mm. The percentages of size classes of MPs recorded in all fish samples are as follows; 16% at 0–0,5 mm, 26% at 0,5–1 mm, 28% at 1–2 mm, 29% at 2–5 mm (Fig. 5). The mean size of MPs extracted from the GITs of some edible fish species off the Turkish coast was recorded as 1.63 ± 0.07 mm (Gündoğdu et al. 2020). The average MPs sizes in different tissues of red mullet and pontic shad from the Black Sea were ranged from 50 to 200 µm (Atamanalp et al. 2021).

The present study and the results of studies conducted worldwide agree that PP and PES are the most common polymer types. PP is a type of plastic mostly used in clothing, packaging, piping, household, medical, food industry, textile, construction, agriculture and disposable products. PES is utilized in textiles, packaging, construction, disposable products and medical application products Nylon has been widely used in many industrial sectors such as socks, curtains, surgical threads, fishing nets, luggage and umbrella fabrics for many years (Gündoğdu et al. 2022). PA has a lower density with 0.895 g/cm^3 and is expected to be more abundant in the water column compared to (PES) with 1.37 g/cm^3 and (PP) with 1.14 g/cm^3. Although it has been suggested that polymer density may affect the amount and types of polymers consumed by pelagic and demersal fish (Lusher et al. 2016), such a difference did not a case in the current study.

Conclusion

The current study revealed the presence of designated MP in two pelagic (*Engraulis encrasicolus*, and *Trachurus trachurus*) and two benthic (*Merlangius merlangus* and *Mullus barbatus*) species collected in Giresun province, Türkiye, on the Southern Black Sea coast. The most common forms of MPs distinguished in the studied species were seen in the fiber type, with the highest rate being 82% in *Engraulis encrasicolus* and the lowest rate being 47% in *Mullus barbatus*. The majority of the extracted MPs were black (41%), followed by blue and red (both 24%) and green (11%). ATR-FTIR spectrophotometry results revealed that Polypropylene (PP) was the dominant polymer type at 56%. MP amounts were relatively lower in *Trachurus trachurus, a pelagic fish* with the mean of 1.6 MP $fish^{-1}$ This suggests that it may be related to the sinking of MP particles and the presence of more MP in benthos, which are the feeding areas of benthic species. On the other hand, the mean MP amounts recorded in anchovy with 1.80 MP $fish^{-1}$, the other pelagic species of the study, were compatible with demersal species.

Even if GIT is removed before cooking, the possible transfer of MPs to edible tissues potentially poses a threat to human food safety. These examined species, which have an ecologically and economically important place in Giresun, are the most preferred and consumed human foods in the Southern Black Sea region. The scientific community should conduct further studies to uncover the potential effects of MP ingestion on human health.

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Author's contributions All authors contributed to the study conception and design. Yalçın Tepe: Conceptualization, investigation, formal analysis, writing—original draft, funding acquisition; Handan Aydın: Sampling, analysis, data curation, methodology resources; Fikret Ustaoğlu: Review, analysis, visualization, resources; Murat Kodat: Sampling, analysis.

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Availability of data and materials The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Declarations

Ethical approval and consent to participate Not applicable.

Consent to publish Not applicable.

Competing interests The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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