Identification of Microplastics in Skipjack Tuna (*Euthynnus affinis*) at the Pangandaran Fish Landing Base, West Java

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ABSTRACT

Abstract

Microplastics are plastic particles smaller than 5 mm that are widely distributed in aquatic environments and can enter and accumulate in marine organisms, including skipjack tuna (Euthynnus affinis). Skipjack tuna is one of the main fishery commodities in Pangandaran and represents an important source of protein for coastal communities. This study aimed to assess the abundance and characteristics of microplastics in the stomachs of skipjack tuna landed in Pangandaran, West Java. A total of 20 individuals were analyzed. Microplastics were isolated by digesting stomach contents with a 10% KOH solution, followed by incubation in a water bath at 70°C and 150 rpm until complete homogenization. The digested samples were filtered using a 250 µm sieve and oven-dried at 40°C for 2 hours prior to microscopic examination. The results indicated that microplastics were present in all stomach samples, with an average abundance of 4.1 particles per individual. Four microplastic types were identified: fragments (19.66%), fibers (28.28%), films (31.04%), and granules (21.03%), exhibiting a range of colors including blue, red, yellow, green, black, white, and transparent. Film-shaped microplastics were the most prevalent (31.04%), and black was the dominant color observed. These findings demonstrate that skipjack tuna landed in Pangandaran are contaminated with microplastics and may serve as effective bioindicators of marine plastic pollution. Continuous monitoring and improved coastal waste management are therefore essential to mitigate the impacts of microplastic contamination.

Keyword: *microplastics, Euthynnus affinis, Pangandaran, marine pollution*

1. INTRODUCTION

The global production and consumption of plastics have increased markedly over recent decades, driven by their extensive application across diverse sectors of human activity. When such growth is not accompanied by effective and sustainable waste management practices, it leads to the accumulation of plastic debris in aquatic environments. Plastics are synthetic materials composed of polymeric compounds formed through the polymerization of hydrocarbon monomers [1]. Based on their physicochemical properties, plastics are broadly classified into thermoplastics—such as polyethylene, polypropylene, nylon, and polycarbonate, which can be repeatedly reshaped through heating—and thermosetting plastics, including melamine, urea, and phenol formaldehyde, which undergo irreversible curing processes [2]. Indonesia has been identified as one of the major contributors of plastic waste entering marine environments worldwide [3]. It is estimated that more than 8 million metric tons of plastic are discharged into the oceans annually, where larger plastic debris undergoes progressive fragmentation into particles smaller than 5 mm, commonly referred to as microplastics [4].

Microplastics are generally categorized into primary microplastics, which are intentionally manufactured at microscopic sizes for industrial and consumer applications (e.g., microbeads in personal care products), and secondary microplastics, which result from the physical, chemical, and biological degradation of larger plastic items [5]. Fragmentation in marine environments is primarily driven by ultraviolet (UV) radiation and mechanical abrasion associated with hydrodynamic forces [6]. Consequently, microplastics have become pervasive contaminants in marine ecosystems, with approximately 88% of marine organisms reported to be affected by plastic pollution (WWF, 2022).

Microplastics are characterized by high environmental persistence, resistance to degradation, and the capacity for long-range transport via ocean currents and coastal anthropogenic activities [1]. Their vertical distribution in the water column—floating, remaining suspended, or settling into sediments—is largely determined by polymer density, such as polyethylene, polypropylene, polystyrene, and polyvinyl chloride [4]. These properties promote frequent interactions between microplastics and marine organisms, particularly pelagic fish species such as *E. affinis*, which forage actively in surface and mid-water layers. Microplastics can enter fish through direct ingestion, trophic transfer via contaminated prey, or uptake through the gills. Following ingestion, particles may accumulate in the gastrointestinal tract, causing physical abrasion, inflammatory responses, and reduced digestive efficiency [7]. Previous studies have consistently reported fibers, films, fragments, and granules as the dominant microplastic morphotypes detected in fish, with blue and transparent particles being the most prevalent due to their visual similarity to natural prey items such as zooplankton [4] [8].

The extent of microplastic accumulation in fish is strongly influenced by feeding strategy and trophic position. Predatory species occupying higher trophic levels tend to exhibit greater microplastic burdens as a result of bioaccumulation along the food web [7]. Beyond physical impacts, microplastics can induce physiological stress responses, including increased production of reactive oxygen species (ROS) and impairment of immune function [4]. Furthermore, microplastics serve as vectors for hazardous chemical contaminants, such as heavy metals, bisphenol A (BPA), phthalates, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs), which may exacerbate toxic effects on fish tissues, including the liver, gills, and gonads [7].

The transfer of microplastics and associated contaminants through marine food webs poses potential risks to ecosystem health and human food safety, particularly via seafood consumption [9]. This concern is especially relevant in Indonesia, an archipelagic nation where marine fish represent a primary source of animal protein. Pangandaran, West Java, is a major fisheries and tourism region experiencing intense anthropogenic pressure, which may contribute to elevated microplastic inputs into local marine environments. The Pangandaran Fish Landing Base (PPI Pangandaran) functions as an important hub for fish distribution, including *E. affinis*, a commercially valuable and widely consumed species [9].

Therefore, this study aims to evaluate the abundance, morphological characteristics (shape and color), and occurrence of microplastics in the stomachs of kawakawa (*Euthynnus affinis*) landed at PPI Pangandaran, West Java. The findings are expected to provide baseline data on microplastic contamination in local marine waters and to contribute scientific evidence supporting sustainable fisheries management and marine pollution mitigation efforts.

2. MATERIALS AND METHODS

Fish Sample Collection

Fish samples were collected using a purposive sampling strategy based on uniform size and physical condition criteria, ensuring that only fresh and undamaged specimens were selected. A total of 20 individuals of *E. affinis* were obtained directly from local fishers at the Pangandaran Fish Landing Base (PPI Pangandaran), West Java, Indonesia. Each specimen was measured for total length (cm) and body weight (g) using a digital caliper and an electronic balance to obtain basic morphometric data.

Microplastic Extraction and Sample Preparation

Each fish specimen was aseptically dissected along the ventral surface to remove the stomach. The excised stomach tissue was placed in a clean glass beaker and treated with a 10% sodium hydroxide (NaOH) solution at a ratio of 1:3 (tissue weight to solution volume) to digest organic material. Digestion was conducted at 60 °C for 24 h on a hotplate, with the beaker covered with aluminum foil to minimize airborne contamination. After digestion, the solution was filtered through a stacked stainless-steel sieve system with mesh sizes of 500 µm and 100 µm to separate solid particles. The residues retained on the filter papers were air-dried at room temperature for approximately 24 h prior to microscopic examination.

Identification and Classification of Microplastics

The filtered residues were examined under a stereo microscope at 40× magnification. Microplastic particles were identified and classified based on their morphological characteristics and color. [4] [8]. Microplastics were categorized into four morphotypes: (i) fibers, characterized by elongated, flexible, thread-like shapes; (ii) films, defined as thin, flexible, sheet-like particles; (iii) fragments, irregularly shaped, rigid particles; and (iv) granules (pellets), spherical or oval particles with smooth surfaces. Particle color was recorded through visual observation and classified into seven categories: blue, red, green, yellow, black, white, and transparent.

Data Analysis

Data were analyzed descriptively and presented as mean microplastic abundance (particles per individual) and as relative percentages of each microplastic morphotype and color category.

3. RESULTS AND DISCUSSION

3.1 Fish Morphometrics

The results of the fish morphometric measurements are presented in Table 1.The total length of *E. affinis* female ranged from 267 to 297 mm, with body weights between 180 and 240 g. Male specimens were slightly larger, with lengths of 276–305 mm and weights ranging from 180 to 280 g.

Table1. Morphometric measurements of *Euthynnus affinis* collected from PPI Pangandaran

Sample	Sex	Total Length (mm)	Weight (gr)	Frag-ment	Fiber	Film	Granule	Abundance (particles per individual)
1	Female	272	220	8	13	9	3	3,3
2	Male	286	250	9	6	7	1	2,3
3	Male	305	280	1	0	7	8	1,6
4	Female	297	230	3	1	3	5	1,2
5	Female	282	225	2	5	15	8	3
6	Jantan	291	255	6	11	17	8	4,2
7	Female	267	180	5	4	10	8	2,7
8	Female	283	240	6	6	10	6	2,8
9	Male	276	225	8	21	5	4	3,8
10	Male	289	180	9	15	7	10	4,1
11	Female	272	220	8	13	9	3	3,3
12	Male	286	250	9	6	7	1	2,3
13	Male	305	280	1	0	7	8	1,6
14	Female	297	230	3	1	3	5	1,2
15	Female	282	225	2	5	15	8	3
16	Male	291	255	6	11	17	8	4,2
17	Female	267	180	5	4	10	8	2,7
18	Female	283	240	6	6	10	6	2,8
19	Male	276	225	8	21	5	4	3,8
20	Male	289	180	9	15	7	10	4,1
Total				114	164	180	122	

3.2 Microplastic Abundance in *Euthynnus affinis*

Analysis of 20 specimens revealed microplastic accumulation in the stomachs, with a mean abundance of 4.1 particles per individual (Table 1). The ubiquitous presence of microplastics indicates widespread contamination in the waters surrounding Pangandaran. These results align with studies of small pelagic fish in Palabuhanratu Bay, which reported a mean microplastic abundance of 3.8 particles per individual [10]. Similarly, research along the southern coast of Java documented microplastics in the gastrointestinal tracts of pelagic fish, highlighting the high risk of ingestion by surface-dwelling species [11]; [12].

3.3 Microplastic Types

Morphological analysis identified four microplastic types: film, fiber, fragment, and granule (Figure 1). Film particles were most prevalent (31.04%), followed by fibers (28.05%), granules (21.03%), and fragments (19.66%). The dominance of film-type microplastics suggests that primary sources include single-use plastic packaging, such as bags, food wrappers, and fishing-related plastics commonly used in coastal Pangandaran. Similar patterns were observed in mackerel (*Rastrelliger* spp.) along northern Java, where film-type dominance was linked to domestic and tourism-related activities [13]. High microplastic abundance in pelagic fish further underscores the extensive contamination along the southern Java coast [14]. Microplastics are known to induce metabolic disruption, tissue inflammation, and facilitate the transfer of toxic chemicals through the food web [4].

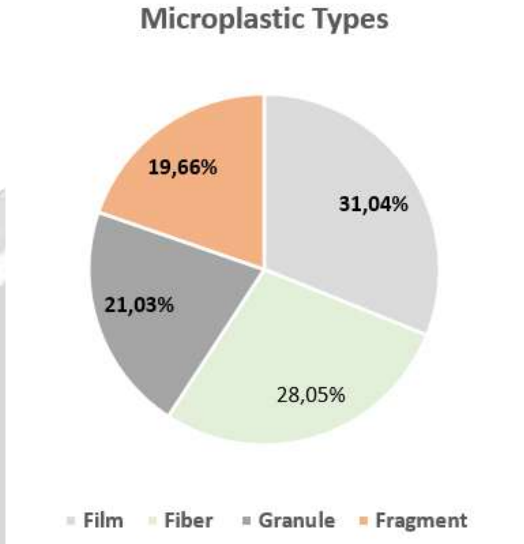

Fig -1. Percentage distribution of microplastic types identified in the stomachs of *Euthynnus affinis* collected from PPI Pangandaran

3.4 Microplastic Colors

Microplastics displayed diverse colors, including blue, black, white, red, and transparent. Blue was most abundant (35.90%), followed by black (27.69%), white (18.46%), red (10.26%), and transparent (7.69%). The predominance of blue and black particles corresponds to common colors of fishing nets, ropes, and industrial plastics [15];[16]. Studies on commercially consumed fish along the southern coast of West Java similarly report blue and black as dominant colors, likely because these resemble plankton or natural food particles, visually attracting pelagic fish and increasing ingestion risk [12]. The presence of other colors, such as red, white, and transparent, indicates additional contamination from domestic and tourism-related sources [17].

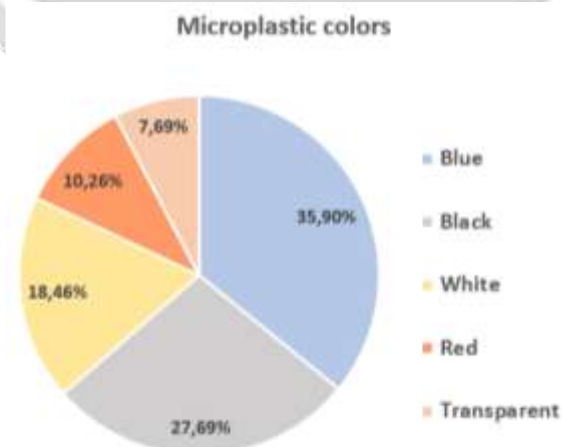

Fig -2. Percentage distribution of microplastic colors identified in the stomachs of *Euthynnus affinis* collected from PPI Pangandaran

3.5 Sources and Distribution Patterns

The distribution of microplastic types and colors suggests that the primary sources of contamination are anthropogenic activities in coastal areas, including:

1. Fishing operations (wear and degradation of nylon nets and plastic ropes);
2. Coastal tourism (increased plastic packaging waste from visitors);
3. Domestic and riverine inputs (plastic waste from nearby settlements entering the sea).

The surface-dwelling behavior of *E. affinis* and local current patterns make this species an effective bioindicator for monitoring microplastic contamination in tropical marine environments. Pelagic fish occupy mid-trophic levels and exhibit wide-ranging movements, enhancing their suitability as bioindicators [18].

3.6 Ecological and Health Implications

Microplastics in *E. affinis* have important implications for marine food webs and human food safety. While most particles remain confined to the gastrointestinal tract, very small particles (<100 µm) may translocate to other tissues via intestinal transport mechanisms [4]. Accumulated microplastics can also carry toxic compounds, including phthalates, bisphenol A (BPA), and heavy metals, which may be transferred to humans through fish consumption.

Ecologically, microplastic presence in commercially important fish reflects disruptions in marine ecosystem functioning. These findings underscore the need for integrated coastal plastic waste management. Mitigation strategies—such as increasing fisher awareness, improving port plastic waste handling, and implementing regular environmental monitoring—are critical to preventing further microplastic pollution in Indonesian waters.

Microplastics enter fish via direct ingestion from the water column and through trophic transfer. Experimental studies demonstrate that microplastic particles can induce intestinal inflammation and oxidative stress [4]. Although most particles remain in the stomach, smaller particles (<100 µm) can translocate to muscle tissue via cellular transport. Microplastics also serve as vectors for persistent organic pollutants (POPs) and heavy metals, increasing the risk of toxicity.This study reinforces evidence of ecological pressure from microplastic contamination along southern Java. High microplastic concentrations in the water column and coastal sediments have been strongly correlated with tourism and fishing activity, suggesting repeated exposure of migrating pelagic fish along the coastline[16] (Hakim et al., 2023).

4. CONCLUSIONS

Euthynnus affinis landed at PPI Pangandaran were contaminated with microplastics, with an average abundance of 4.1 particles per individual (<3 mm). Four microplastic types were identified in the stomachs: film (31.04%), fiber (28.28%), granule (21.03%), and fragment (19.66%). Detected microplastic colors included blue, red, yellow, green, black, white, and transparent, with blue being most dominant. These findings indicate that Pangandaran's marine environment is contaminated with microplastics and that *E. affinis* may serve as a bioindicator of coastal water quality

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