

MICROPLASTIC CONTAMINATION IN CLIMBING PERCH (*Anabas testudineus*) FROM FRESHWATER ENVIRONMENTS IN SOUTH KALIMANTAN, INDONESIA

Kontaminasi Mikroplastik pada Ikan Betok (*Anabas testudineus*) di Perairan Tawar Kalimantan Selatan, Indonesia

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ABSTRACT

Plastic pollution is a global issue with significant impacts on aquatic environments, including freshwater ecosystems. Microplastics (MPs), plastic particles measuring less than 5 mm, originate from both primary and secondary sources and have the potential to accumulate in aquatic organisms. This study aimed to identify the presence, morphological characteristics, and polymer types of microplastics in climbing perch (*Anabas testudineus*) sold at Bauntung Market, Banjarbaru, South Kalimantan. Fish samples were dissected to remove the gastrointestinal tract, digested using a 10% KOH solution, and examined under a stereo microscope, followed by polymer identification using *Fourier Transform Infrared Spectroscopy* (FTIR). The results showed two microplastic particles in the gastrointestinal tract, both as blue-colored fibers (line) measuring 1.894 mm and 2.469 mm. FTIR analysis identified polyester (PS) as the dominant polymer. These findings indicate that *A. testudineus* in freshwater environments is exposed to microplastics potentially derived from synthetic textile fibers, domestic waste, or fishing activities, with implications for ecosystem health and potential human exposure through the food chain. *A. testudineus* can serve as a bioindicator of microplastic contamination in freshwater, highlighting the need for improved waste management and continuous water quality monitoring.

Keywords: *Anabas testudineus*, Microplastics, Freshwater, Polyester (PS).

ABSTRAK

Polusi plastik merupakan masalah global yang berdampak signifikan terhadap lingkungan perairan, termasuk ekosistem air tawar. Mikroplastik (MP), partikel plastik berukuran <5 mm, dapat berasal dari sumber primer maupun sekunder, dan berpotensi terakumulasi dalam tubuh organisme akuatik. Penelitian ini bertujuan mengidentifikasi keberadaan, karakteristik morfologi, dan jenis polimer mikroplastik pada ikan Betok (*Anabas testudineus*) yang dijual di Pasar Bauntung, Banjarbaru, Kalimantan Selatan. Sampel ikan dianalisis melalui proses pembedahan saluran pencernaan, digesti jaringan menggunakan larutan KOH 10%, dan observasi partikel di bawah mikroskop stereo, dilanjutkan dengan analisis polimer menggunakan *Fourier Transform Infrared Spectroscopy* (FTIR). Hasil penelitian menunjukkan adanya dua partikel mikroplastik berbentuk *line* (serat) berwarna biru, berukuran 1,894 mm dan 2,469 mm. Analisis FTIR mengidentifikasi polimer *polyester* (PS) sebagai komposisi utama. Temuan ini mengindikasikan paparan mikroplastik pada ikan air tawar yang berpotensi berasal dari serat tekstil sintetis, limbah domestik, atau aktivitas perikanan, serta berimplikasi terhadap kesehatan ekosistem dan potensi risiko pada manusia melalui rantai makanan. Ikan Betok berpotensi digunakan sebagai bioindikator pencemaran mikroplastik di perairan tawar, sekaligus menegaskan pentingnya peningkatan pengelolaan limbah dan pemantauan kualitas perairan secara berkelanjutan.

Kata Kunci: *Anabas testudineus*, Mikroplastik, Perairan Tawar, *Polyester* (PS)

INTRODUCTION

Plastic pollution is a global problem due to its impact on the environment and the limited recyclability of plastic waste (Dong *et al.*, 2020). Researchers estimate that 24-34 million metric tons of plastic waste entered aquatic ecosystems in 2020 (Borrelle *et al.*, 2020). Public estimates of plastic waste generally point to suboptimal solid waste management from human activities as the primary source (Jambeck *et al.*, 2015) as one pathway for plastic pollution. However, further research is needed regarding other sources, such as waste disposal from fisheries (Yusuf & Effendi, 2024), agricultural waste (Khodijah & Tobing, 2023), runoff (We *et al.*, 2023), and liquid waste from wastewater treatment plants (Nurhasmi *et al.*, 2021).

Microplastics (MPs) are plastic fragments measuring <5 mm (GEMSAMP, 2019) originating from two sources: primary and secondary. Primary sources of microplastics come from plastics produced directly for specific industrial or household uses, such as facial scrubs, toothpaste, and resin granules used in the plastics industry. Secondary sources include plastics formed from the breakdown of larger plastics due to ultraviolet radiation or mechanical abrasion (IMO, 2015).

Microplastics in aquatic environments are of concern due to their high mobility and long-lasting nature. Physical and chemical factors in aquatic environments, such as hydrodynamics, entanglement, and absorption by water, also influence the sedimentation and transport distance of microplastics, ultimately contributing negatively to the aquatic environment (Huang *et al.*, 2021). The physical and chemical degradation of plastics also contributes to the formation of microplastic particles, which pose environmental risks (Gorfad *et al.*, 2024).

Microplastics are not limited to aquatic ecosystems but are also found in aquatic organisms, including fish for consumption. This situation raises concerns about the potential for microplastic contamination of humans through the food chain. Various studies in Indonesia have identified microplastics in various species, such as Tilapia (*Oreochromis niloticus*) in the Porong River, East Java (Seftianingrum *et al.*, 2023), Snakehead fish (*Channa striata* B.), and Baung fish (*Mystus nemurus*) in Samarinda (Septiana *et al.*, 2021), Biawan fish (*Helostoma temmincki* Cuvier), Betok fish (*Anabas testudineus*), Kapar fish (*Belontia*

hasselti), and Snakehead fish (*Channa striata*) caught by fishermen in the Barito River, South Kalimantan (Amin, 2022). However, studies related to the accumulation of microplastics in fish organs are still limited. Therefore, this study was conducted to identify and analyze the presence of microplastics in climbing perch (*Anabas testudineus*) marketed at Bauntung Market, Banjarbaru, South Kalimantan.

RESEARCH METHODS

Place and Time

The research was conducted in January 2025. Fish samples were collected at Bauntung Market, Banjarbaru City, South Kalimantan Province. Sample preparation took place at the Bioecology Laboratory, Faculty of Fisheries and Marine Sciences, Lambung Mangkurat University. Sample identification and analysis were then conducted at the Marine Ecotoxicology Laboratory, Faculty of Marine Sciences and Fisheries, Hasanuddin University. Polymer type analysis was conducted at the Organic Laboratory, Faculty of Agriculture, Hasanuddin University.

Tools and Materials

The equipment used was a scalpel, digital scales, Erlenmeyer flasks, beakers, measuring cylinders, droppers, measuring pipettes, petri dishes, slides, object glasses, placon bottles or vials, aluminum foil, hotplates, funnels, cutters, filter paper, label paper, latex gloves, ovens, stirring rods, basins, tissues, rulers, pens, notebooks, cellphone cameras, laptops, and stereo microscopes.

The materials used in the study were climbing perch (*Anabas testudineus*) including aluminum foil, disposable latex gloves, masks, 70% alcohol, saturated NaCl solution (Merck), KOH pro-analysis powder MERCK 1.05033.1000, distilled water, and aquabidest (Gesamp, 2019).

Research Procedure

a) Fish Sampling

Two individuals of climbing perch (*Anabas testudineus*) were obtained from Bauntung Market, Banjarbaru City, South Kalimantan in January 2025. The sampling method was purposive sampling, with the criteria of fresh fish, intact body size, and no external organ damage. Purposive sampling was chosen because it is effective in obtaining samples according to research objectives (Etikan, 2016; Palinkas *et al.*, 2015). The samples were placed in sterile containers lined with aluminum foil, then stored at a cold temperature (± 4 °C) until analysis in the laboratory.

b) Equipment Preparation and Sterilization

All equipment used, such as scalpels, scissors, tweezers, petri dishes, and other equipment, are first sterilized using 70% ethanol to prevent cross-contamination. (Foekema *et al.*, 2013).

c) Surgery and Removal of the Gastrointestinal Tract

The surgical procedure was performed on a paraffin-embedded surgical board, beginning with an incision from the anus down the back to the mid-rib line (linea lateralis), then extending to the head and abdomen to expose the digestive tract. The digestive tract was removed intact using sterile forceps and placed in a sealed glass sample vial.

d) Surgery and Removal of the Gastrointestinal Tract

The tissue digestion process was carried out by adding a 10% potassium hydroxide (KOH) solution with a solution to tissue ratio of 3:1 (w/v). The sample was then incubated at

room temperature for 14 hours until all organic tissue was completely decomposed. A 10% KOH solution was chosen as the digestion agent because it has high effectiveness in completely degrading organic tissue in the digestive tract, while maintaining the structural integrity of most types of plastic polymers. The use of this method can also minimize the potential for degradation or changes in the physical and chemical properties of microplastics during the digestive tract digestion process (Dehaut *et al.*, 2016; Karami *et al.*, 2017).



Figure 1. a) Surgical process on the stomach; b) removal of the digestive tract (intestines); c) digestive process of the digestive tract.

e) Microplastic Identification Process

The digested residues were observed using a stereo microscope to identify microplastic particles based on their shape, color, and size (Hidalgo-Ruz *et al.*, 2012). The identified particles were then carefully transferred to a glass slide using microtweezers or an eyepiece needle, and then analyzed using Fourier Transform Infrared Spectroscopy (FTIR) to determine the polymer type. (Song *et al.*, 2021).

Data Analysis

This study used a quantitative descriptive approach, with data sources derived from the identification and characterization of microplastics in climbing perch (*Anabas testudineus* (Bloch, 1792)). The data were analyzed to describe the number, type, shape, color, and dimensions of the particles found. This approach helps generate systematic information about contamination levels and provides an initial overview of possible sources of pollution and the ecological impacts of microplastics in freshwater (Djamba dan Neuman, 2002).

RESULT

Microplastic Contamination in Fish

This study used the climbing perch (*Anabas testudineus*) as the target species due to its abundance in freshwater and its ability to adapt to various environmental conditions, including degraded waters. The fish species identification process was carried out carefully using the online scientific database FishBase, which provides accurate and standardized taxonomic information and morphological characteristics of fish.

Analysis of the climbing perch revealed two microplastic particles in the digestive tract, indicating that the climbing perch had been exposed to microplastics through contaminated water or through food, which disrupted the digestive process.



Figure 2. Betok fish
Source: Research Sample, 2024

Characteristics of Microplastics

Morphological analysis of microplastics found in the climbing perch (*Anabas testudineus*) showed that the detected particles were blue in color, with lines (fibers) measuring 1.894 mm and 2.469 mm, respectively. The line shape indicates physical characteristics such as being light, flexible, and easily carried by currents, thus having a high potential for widespread distribution in aquatic environments.

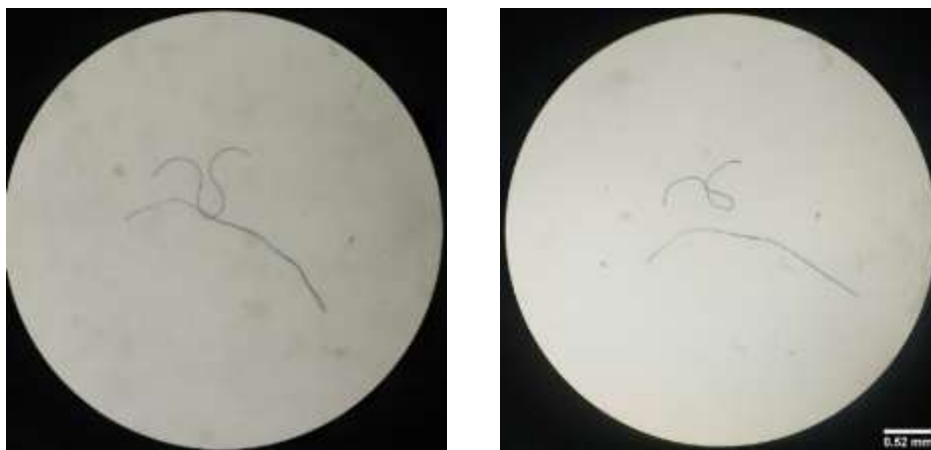


Figure 3. Line-shaped microplastics

Microplastic Polymers

The analysis results showed that the polymer of the microplastic particles found in the climbing perch samples was polyester (PS). The test results are presented in Figure 4.

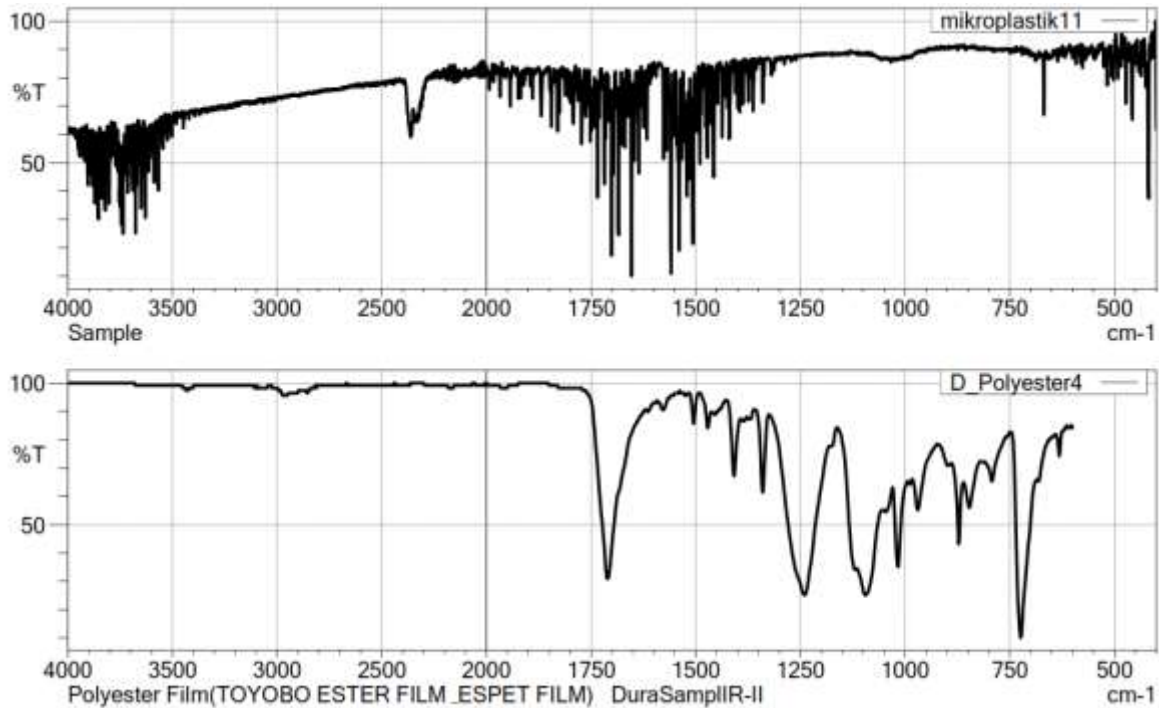


Figure 4. Polyester Polymer Spectrum (PS)

Figure 4 shows that the upper curve (mikroplastik11) represents the spectrum of microplastic particles isolated from the fish body, while the lower curve (D_Polyester4) is the reference spectrum of polyester (PS). The matching absorption patterns of both indicate the identification of the polymer as polyester (PS), with a characteristic peak at 1715 cm^{-1} indicating a carbonyl group (C=O) and a peak at $1250\text{--}1000\text{ cm}^{-1}$ representing a C–O bond (Kahali *et al.*, 2022). These peaks are characteristic of the chemical structure of polyester and are valid indicators for confirming polymer identification.

DISCUSSION

Microplastic Contamination in Fish

According to Browne *et al.*, 2013, microplastics can pass through or persist in the digestive tract depending on particle size, which can cause blockages and disrupt the digestive process in fish. Microplastic contamination in fish has potential health impacts, including impaired physiological function, reduced immunity, and the accumulation of toxic substances. This is in line with research by Amin (2022) that found that ingested microplastics disrupt the fish's metabolic system and reduce appetite. Furthermore, according to Wright *et al.*, 2013, other potential effects include decreased growth rate, inhibition of enzyme production, decreased steroid hormone levels, reproductive system disruption, and increased exposure to toxic plastic additives.

According to Frias and Nash (2019), microplastics (MPs) are defined as synthetic solid particles or polymer matrices ranging in size from $1\text{ }\mu\text{m}$ to 5 mm and less than $1\text{ }\mu\text{m}$. Microplastics in the environment originate from various pathways, both directly produced and formed through the degradation of larger plastics. Primary sources include microplastics intentionally produced for cosmetic products, industrial abrasives, and plastic pellets, with significant contributions from personal care product waste, household wastewater, and wastewater treatment sludge (An and Ling, 2021; Singh *et al.*, 2024). Secondary sources are formed through the fragmentation of large plastics such as plastic bags, bottles, and fishing gear into smaller particles due to weathering, friction, and biological processes, which

predominate in the environment due to uncontrolled plastic use and disposal (Khan and Bose, 2024;). Furthermore, industrial and domestic waste, including textile fiber shedding during washing, vehicle tire wear, and plastic packaging waste, also play a significant role, as wastewater treatment plants are generally not capable of fully filtering microplastics (Singh *et al.*, 2021; Gorfad *et al.*, 2024). Other pathways include agricultural waste and urban runoff, for example from the use of plastic mulch and fertilizers, and runoff from roads and construction projects, with tire wear becoming a significant source as the number of vehicles increases globally. (An & Ling, 2021; Microplastics in the Environment, 2022).

Characteristics of Microplastics

Microplastics observed in the climbing perch (*Anabas testudineus*) appear morphologically in the form of blue fibers (lines). The blue color of microplastics is often associated with sources such as synthetic textile fibers, plastic ropes, or polymer materials used in fishing and household activities (Hidalgo-Ruz *et al.*, 2012).

The findings of microplastics in climbing perch confirm the pressure of plastic pollution in the ecosystem where the fish live. The presence of microplastics in the bodies of climbing perch indicates exposure to plastic pollution in the aquatic environment where the fish live. The lines in microplastics generally originate from textile waste, fishing nets, or plastic debris that degrades in the water. The lines identified are most likely derived from anthropogenic sources, including textile waste, fishing gear, and degraded plastic fragments. According to Purnama *et al.*, (2021), microplastics that are elongated and thin, like the threads on fishing lines or nets, are a type of line that tends to remain longer on the water surface due to their relatively low density. Research (Erlangga *et al.*, 2022) found that fiber/line-type microplastics were frequently found in the Belawan Fish Auction Place (TPI), a fishing ground with a high population density and intensive industrial activity.

This finding strengthens evidence that the source of microplastics in freshwater bodies originates not only from the degradation of large plastics, but also from human activities that produce small, fibrous plastic waste (Biginagwa *et al.*, 2016; Napper & Thompson, 2016). The relatively small particle size (<5 mm) makes it easy for microplastics to be ingested by aquatic organisms, either intentionally while foraging or accidentally through water filtration (Li *et al.*, 2015; Wright *et al.*, 2013).

The microplastics found in this climbing perch are similar to research (Amin, 2022), which reported that the dominant microplastics in climbing perch caught in the Barito River were line or fiber-shaped, with six particles. Research by Puspita *et al.* (2023) in Rawa Pening revealed that four forms of microplastics were found in the organs of fish for consumption: fragments, fibers, films, and foam. Meanwhile, research by Rizqiyah *et al.* (2021) found that fiber or line-type microplastics were most commonly found in fish in the Lower Bengawan Solo River.

The predominance of blue in the microplastics found in this study could be an indicator of the source of contamination, for example, synthetic fibers from clothing or fishing equipment. Nor and Obbard (2014) reported that fiber-shaped microplastics were the most common type, accounting for approximately 72% of the total identified. The primary compositions were polypropylene, polyvinyl chloride, and nylon, which are widely used in the fishing net, fabric, and binding industries.

Microplastics that accumulate in freshwater fish have the potential to cause various health problems. These particles can cause tissue damage and trigger inflammation, thus disrupting the physiological functions of the fish (Banaee *et al.*, 2024). Furthermore, exposure to microplastics can disrupt cellular processes, leading to oxidative stress and decreased immune system function (Banaee *et al.*, 2024; Bhuyan, 2022). Behavioral changes can also occur in exposed fish, which in turn impacts survival and reproductive rates (Bhowmik & Basu,

2024). From a human health perspective, consuming fish containing microplastics can serve as a pathway for these particles and their associated toxins to enter the human body. This accumulation poses health risks, including oxidative stress and potential neurotoxicity (Saha & Saha, 2024; Bhuyan, 2022). Furthermore, the presence of microplastics in the food chain can amplify their toxic impacts, affecting not only fish but also organisms at higher trophic levels, including humans (Banaee *et al.*, 2024; Bhowmik & Basu, 2024).

Microplastic Polymers

Microplastic contamination, particularly from polyester (PS) polymers, has been identified in various fish samples, raising concerns regarding food safety and human health. Studies conducted in various regions, including the Gulf of Thailand and Lake Amatitlán, have consistently reported the presence of microplastics in the digestive tracts of fish. Polyester was one of the most frequently detected polymers. In the Gulf of Thailand, polyester was identified as the dominant polymer among microplastics, found in 46.9% of fish samples, with an average of 1.6 particles per fish (Srisiri, 2020; Srisiri *et al.*, 2024). Similar findings were also reported in Lake Amatitlán, where various polymers, including polyester, were extracted from the digestive tracts of fish (Quevedo-López *et al.*, 2024). Estimated daily microplastic exposure for marine fish consumers was found to be low, ranging from 0.03 to 0.1 particles per fish (Srisiri *et al.*, 2024). Although the risk associated with muscle tissue contamination is relatively low, ongoing monitoring is recommended to assess long-term health impacts (Srisiri *et al.*, 2024).

The presence of polyester as the dominant polymer in fish samples suggests that the primary source of microplastics is likely synthetic textile fibers released during laundry, domestic wastewater, and textile and plastics industry activities (Napper and Thompson, 2016). Polyester found in fish is generally in the form of micro-sized blue fibers (<5 mm), which are one of the most common forms of microplastic pollution in aquatic environments (Browne *et al.*, 2011). The primary source of polyester fibers is the degradation of polyester macroplastics and the release of microfibers from synthetic clothing during the laundry process (Palacios-Mateo *et al.*, 2021). These microfibers are carried by domestic wastewater into water bodies and ultimately end up in the ocean, contributing to the contamination of aquatic biota (Napper & Thompson, 2016).

The discovery of polyester polymers in climbing perch strengthens evidence that microplastic pollution has reached freshwater ecosystems and has the potential to enter the human food chain. Polyester fibers have the potential to carry hazardous additives or absorb persistent organic pollutants (POPs) such as PCBs and PAHs from the environment, thereby increasing the risk of toxicity to aquatic organisms and humans (Andrady, 2017; Rochman, 2015). Polyester polymers are known to have toxic effects on aquatic organisms, including digestive disorders, tissue inflammation, oxidative stress, and other physiological disorders. (Barboza *et al.*, 2018; Wright *et al.*, 2013).

The climbing perch, known for its high tolerance to polluted waters, has the potential to be used as a bioindicator to monitor microplastic contamination levels in freshwater ecosystems. Utilizing this local species could support more accurate mapping of microplastic exposure risks and become part of an ecosystem-based pollution control strategy. The findings of this study also emphasize the urgency of strengthening domestic waste management, increasing the efficiency of wastewater treatment plants (WWTPs), and implementing routine water quality monitoring, particularly in densely populated areas and industrial areas, to minimize microplastic exposure to aquatic ecosystems and human health (Andrady, 2017; De Falco *et al.*, 2019; UNEP, 2021).

CONCLUSION

Research on the climbing perch (*Anabas testudineus* (Bloch, 1792)) revealed two microplastic particles detected in the digestive tract. The microplastics were blue in color and measured 1.894 mm and 2.469 mm, respectively. Polymer identification using Fourier Transform Infrared Spectroscopy (FTIR) confirmed that the particles were polyester (PS).

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