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Types and Abundance of Microplastics in African Catfish (*Clarias gariepinus*) from Sumber Agung Village, Parigi Moutong

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Abstract: This study aimed to determine the types and abundance of microplastics in African catfish (*Clarias gariepinus*) collected from aquaculture ponds and a river in Sumber Agung Village. A descriptive research design was employed using both qualitative and quantitative approaches. A total of 10 catfish aged approximately two months were used as samples, consisting of five individuals from aquaculture ponds and five individuals from the river. Digestive tract samples were digested using 10% KOH solution for 96 hours to separate microplastic particles, followed by filtration, identification, and particle counting. The results showed that microplastics were detected in all catfish samples. Three types of microplastics were identified: fibers, films, and fragments. The abundance of microplastics in catfish from aquaculture ponds was 103.6 particles/individual, which was higher than that observed in catfish from the river, at 57.6 particles/individual. Fragments were the dominant microplastic type in pond-derived catfish, whereas fibers predominated in river-derived catfish. Differences in microplastic abundance were influenced by the characteristics of the aquatic environment, with ponds having limited water circulation that may facilitate microplastic accumulation. These findings indicate that catfish have the potential to serve as bioindicators of microplastic pollution in both aquaculture systems and natural freshwater environments. However, microplastic identification in this study was based solely on microscopic observation; therefore, the polymer composition of the detected microplastics could not be confirmed.
Keywords: *Clarias gariepinus*; microplastics; digestive tract; freshwater environment

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INTRODUCTION

Global plastic production continues to increase in line with industrial development, urbanization, and the extensive use of single-use packaging. According to the United Nations Environment Programme (UNEP, 2023), global plastic production has exceeded 430 million tons per year, with a large proportion becoming waste after a single use. Plastic waste has become a serious environmental problem because it is difficult to degrade naturally and requires approximately 100–500 years to decompose, depending on the type of plastic and environmental conditions (Yati, 2021). During degradation, plastics break down into small particles measuring less than 5 mm, known as microplastics (Junaidi et al., 2024). These particles vary in size, color, shape, composition, density, and other characteristics (Azizah et al., 2020).

Microplastics can enter aquatic environments through domestic waste, agricultural activities, transportation, and rainwater runoff. Because of their small size, microplastics are easily ingested by aquatic organisms, including fish, and may cause physiological disturbances, such as damage to the digestive system, metabolism, and reproductive function (Bahri, 2022; Riska et al., 2022). In addition, hazardous chemical compounds contained in plastics, such as bisphenol A and phthalates, can accumulate in organisms and disrupt the balance of aquatic ecosystems (Yumni et al., 2021).

Sumber Agung Village, Parigi Moutong Regency, is one of the areas where African catfish (*Clarias gariepinus*) farming is managed by local communities as a source of food and household income. However, the increasing use of plastic in domestic activities has raised the potential for aquatic environments in this area to become contaminated by poorly managed plastic waste. Some aquaculture ponds use river water as their water source, which may allow microplastic particles to enter the culture environment. This condition increases the risk of microplastic exposure in fish intended for human consumption, which may subsequently enter the human food chain and pose adverse impacts on human health and aquatic environments (Firdaus & Zen, 2025).

African catfish (*Clarias gariepinus*) is a freshwater fish that inhabits the bottom layer of aquatic environments and has a feeding habit of directly ingesting food, making it potentially susceptible to microplastic accumulation from its surroundings. Kartini et al. (2023) reported that microplastic exposure in catfish can disrupt the digestive tract, growth, and reproductive system. Similarly, Puspita et al. (2022) found that catfish (*Clarias* sp.) collected from rivers contained microplastics in their digestive tracts, with fragments and fibers as the dominant types. The presence of these microplastics was presumed to originate from domestic waste and human activities around aquatic environments.

Although studies on microplastics in freshwater fish have been widely conducted, research on the presence of microplastics in African catfish (*Clarias gariepinus*) from community-based aquaculture areas in Sumber Agung Village remains very limited. Moreover, no study has reported the identification of microplastics in catfish collected from both aquaculture ponds and rivers in this area. These two aquatic sources have different environmental characteristics, yet both are used by the local community as sources of fishery resources. Catfish were selected in this study because they are widely consumed and live near the bottom of aquatic environments, making them potential bioindicators of microplastic pollution in aquatic ecosystems. Therefore, this study aimed to identify the types and determine the abundance of microplastics in the digestive tract of African catfish (*Clarias gariepinus*) collected from aquaculture ponds and rivers in Sumber Agung Village, Parigi Moutong Regency.

METHOD

Research Design

This study employed a descriptive method with qualitative and quantitative approaches to identify the types and determine the abundance of microplastics in the digestive tract of African catfish (*Clarias gariepinus*) collected from aquaculture ponds and a river in Sumber Agung Village, Parigi Moutong Regency. The study was exploratory in nature and aimed to verify the presence of microplastics in catfish from the two aquatic environments.

Research Location and Samples

This study was conducted from January to February 2026. Catfish samples were collected from river and pond waters in Sumber Agung Village, Parigi Moutong Regency, while analysis of the digestive tract of *Clarias gariepinus* was carried out at the Biology Laboratory, Faculty of Teacher Training and Education, Tadulako University. A total of 10 *Clarias gariepinus* specimens were used, consisting of five fish from aquaculture ponds and five fish from the river. Samples were selected based on fish availability at the study sites. The fish used in this study had a body length of approximately 15–20 cm, a weight of 80–150 g, and an age of approximately two months. Sampling was conducted directly at each aquatic site. The organ analyzed in this study was the digestive tract of the catfish.

Sample Preparation

Microplastic separation from the internal organs of catfish was performed using the method applied by Yudhantari et al. (2019) for fish stomach samples. The fish were dissected to obtain the digestive tract, which was then placed in a 250 mL Erlenmeyer flask. The digestive tract was subsequently immersed in 10% KOH solution until all parts of the organ were fully submerged. Digestion was carried out for 96 h at 40°C to dissolve organic matter. After digestion, the solution was filtered using circular Whatman No. 1 filter paper with a diameter of 125 mm (Cat. No. 1001 125) to separate microplastic particles from the remaining solution. The filter paper was then wrapped in aluminum foil and dried at 50°C for 48 h.

Microplastic Identification

Particles obtained from filtration and drying were observed under a microscope at 10× magnification. Microplastics were identified visually based on particle shape, color, and physical characteristics. The microplastic types identified included fibers, films, and fragments (Widianarko & Hantoro, 2019). The number of microplastic particles found in each fish sample was then counted. Microplastic abundance was expressed as particles per individual.

Data Analysis

Microplastic identification data were analyzed descriptively and presented in tables and graphs. The analysis was conducted to describe the presence, types, and abundance of microplastics in the digestive tract of *Clarias gariepinus* collected from aquaculture ponds and the river in Sumber Agung Village. Microplastic abundance was calculated for each catfish sample from each sampling location or station using the abundance formula. Microplastic abundance was calculated according to Ali (2023) as follows:

$$K = (Ni)/N$$

Note:
K = microplastic abundance, expressed as particles per individual
Ni = number of microplastic particles found, expressed as particles
N = number of samples, expressed as individuals

Research Limitations

This study had several limitations. Microplastic identification was conducted only through visual observation using a microscope at 10× magnification, without polymer-type confirmation using instruments such as Fourier-transform infrared spectroscopy (FTIR) or Raman spectroscopy. In addition, this study did not specifically include blank tests or laboratory contamination controls; therefore, contamination by microplastic particles from the surrounding environment during the research process may still have occurred.

RESULTS AND DISCUSSION

The results of this study confirmed the presence of microplastic contamination in catfish (*Clarias gariepinus*) collected from Sumber Agung Village, Parigi Moutong Regency. Microplastic particles were detected in the digestive organs of catfish from both sampling stations, indicating that fish from both pond and river environments had been exposed to microplastic pollution. The types and abundance of microplastics identified in the samples are presented in Table 1.

Table 1. Types and abundance of microplastics detected in catfish (*Clarias gariepinus*)

Sampling Station	Number of Samples	Fiber	Film	Fragment	Total Particles	Microplastic Abundance (particles/individual)
Station I: Pond	5	134	189	195	518	103.6
Station II: River	5	159	75	54	288	57.6

As shown in Table 1, three types of microplastic particles were identified in catfish from both sampling stations, namely fibers, films, and fragments. At Station I, which represented the pond environment, a total of 518 microplastic particles were detected from five fish samples. These consisted of 134 fiber particles, 189 film particles, and 195 fragment particles, with an average abundance of 103.6 particles per individual. In contrast, catfish collected from Station II, which represented the river environment, contained a total of 288 microplastic particles, comprising 159 fibers, 75 films, and 54 fragments, with an average abundance of 57.6 particles per individual. These results indicate that the total abundance of microplastics was higher in catfish from the pond than in those from the river.

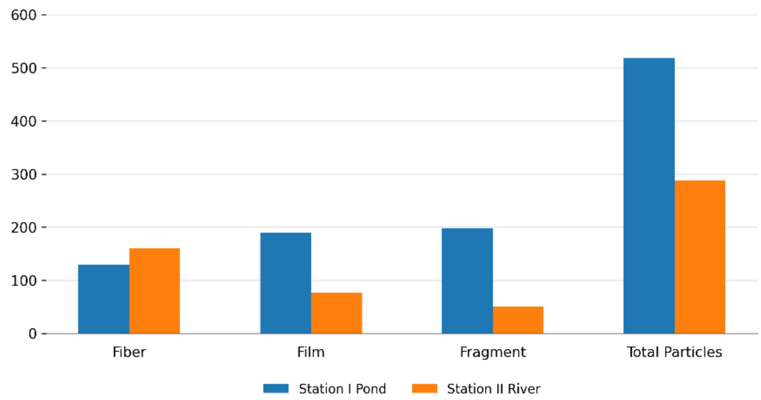

Figure 1. Comparison of the number and types of microplastics detected in catfish (*Clarias gariepinus*) from the pond and river sampling stations.

(a) (b) (c)

Figure 2. Types of microplastics identified in the digestive organs of catfish: (a) fiber, (b) film, and (c) fragment. Magnification: 10×. Source: Research documentation, 2026.

The higher abundance of microplastics in catfish from Station I suggests that pond environments may promote greater retention and accumulation of microplastic particles than riverine environments. Aquaculture ponds are generally characterized by limited water exchange and relatively low circulation. Under such conditions, microplastic particles entering the pond tend to remain within the system, settle into the sediment, and become available for ingestion by aquatic organisms. Previous studies have reported that fish ponds and other small aquatic systems may function as accumulation zones or sinks for microplastics, particularly when they receive inputs from surrounding human activities and surface runoff (Wang et al., 2020; Hossain et al., 2023). In the present study, the pond was located relatively close to residential areas, which may have increased the possibility of plastic waste input from domestic activities.

The accumulation of microplastics in pond environments is also closely related to sedimentation processes. Microplastic particles that are denser than water or that become attached to organic matter can settle at the bottom of the pond, where they may persist for long periods. This condition is ecologically relevant because catfish are demersal fish that actively forage near or on the bottom substrate. As a result, they have a high probability of ingesting microplastics that have accumulated in sediments, either directly during feeding activity or indirectly through contaminated food items. Li et al. (2019) stated that microplastics deposited in freshwater sediments have a high potential to be ingested by benthic and demersal organisms. Similarly, Roch et al. (2020) explained that microplastic uptake in fish may occur through several pathways, including accidental ingestion during feeding, confusion with natural prey, and trophic transfer through contaminated food chains.

Another factor that may contribute to the higher microplastic abundance in pond catfish is the use of artificial feed and aquaculture-related materials. In pond-based aquaculture systems, feed residues, feed packaging, plastic sacks, ropes, nets, pipes, and other polymer-based equipment may serve as potential sources of microplastic particles when they degrade over time. Fred-Ahmadu et al. (2024) reported that aquaculture systems use various plastic materials, including feed sacks, nets, ropes, and plastic equipment, which can fragment into smaller particles and contribute to microplastic contamination in aquatic environments. Therefore, in addition to domestic plastic waste from nearby settlements, aquaculture practices may also increase microplastic input into pond ecosystems.

In contrast, the lower abundance of microplastics in catfish from Station II may be related to the hydrodynamic characteristics of the river. River systems are generally more dynamic than ponds because they are influenced by continuous water flow, turbulence, dilution, and downstream particle transport. These processes can reduce the accumulation of microplastics at a single sampling point by redistributing particles along the river channel. Owowenu et al. (2023) emphasized that flow velocity, water depth, turbulence, bed roughness, and channel morphology strongly influence the distribution, retention, and transport of microplastics in riverine systems. Therefore, the lower microplastic abundance observed in river catfish in this study may reflect the greater capacity of flowing water to disperse or transport microplastic particles downstream.

The composition of microplastic types also differed between the two sampling stations. In catfish from Station I, fragments were the dominant microplastic type, with 195 particles or an average of 39 particles per individual. Films were the second most abundant type, with 189 particles or 37.8 particles per individual, followed by fibers with 134 particles or 26.8 particles per individual. This pattern suggests that pond catfish were more exposed to microplastics originating from the degradation of larger plastic materials. Fragment-type microplastics are commonly produced by the breakdown of rigid plastic waste, such as beverage bottles, plastic folders, detergent containers, food packaging, and other household plastic products. Hossain et al. (2023) also reported that fragments and films are among the dominant microplastic forms in fish culture ponds, and that their occurrence is often associated with degraded plastic materials from surrounding human activities.

Morphologically, fragment-type microplastics are generally irregular in shape, relatively thick, angular, and may appear yellowish to reddish under microscopic observation. The dominance of fragments in the pond samples may be explained by the relatively stagnant condition of pond water, which allows degraded plastic particles to remain in the system and accumulate over time. In addition, limited water movement in ponds may reduce particle removal, allowing plastic debris to undergo continuous physical, chemical, and biological degradation until it forms smaller fragment particles. This finding indicates that pond environments near residential areas may receive continuous inputs of larger plastic debris that subsequently degrade into secondary microplastics.

Film-type microplastics were also detected in relatively high numbers, particularly in catfish from the pond. The abundance of film particles reached 37.8 particles per individual in Station I and 15 particles per individual in Station II. Film microplastics generally originate from thin plastic materials, such as plastic bags, food wrappers, and transparent packaging materials (Hawke, 2022). These particles are usually thin, flexible, and lightweight, which allows them to float in the water column or be transported by water movement. Under microscopic observation, films may resemble fragments; however, they are typically thinner, more transparent, and more sheet-like in appearance. The higher abundance of films in pond catfish may be associated with the accumulation of packaging waste around the pond area and the limited circulation that prevents these particles from being flushed out of the system.

Fiber-type microplastics showed a different pattern. Although the total abundance of microplastics was higher in the pond, fibers were more dominant in catfish from the river. At Station II, fiber particles reached 159 particles, equivalent to 31.8 particles per individual, making them the dominant microplastic type in river catfish. In comparison, catfish from the pond contained 134 fiber particles, or 26.8 particles per individual. Fiber microplastics commonly originate from synthetic textiles, laundry wastewater, fishing nets, ropes, and other plastic-based fibrous materials (Mauludy et al., 2019). Fishing activities may also contribute to fiber contamination through the degradation of nets, lines, and ropes made of synthetic polymers such as nylon, polypropylene, polyester, and polyethylene (Fred-Ahmadu et al., 2024).

The dominance of fibers in catfish from the river may be related to the physical characteristics of fiber particles. Fibers are elongated, lightweight, and thread-like, which allows them to remain suspended in the water column and be transported over long distances by flowing water. This characteristic may explain why fibers are commonly reported as one of the most widely distributed microplastic types in aquatic environments. Riska et al. (2022) stated that fibers are among the most common microplastic forms found in water and sediment and are therefore highly available for ingestion by aquatic organisms. Morphologically, fiber microplastics are characterized by long, thin, thread-like shapes resembling strings, with colors ranging from pigmented to transparent when observed under a microscope.

Overall, the detection of fibers, films, and fragments in the digestive organs of catfish confirms that *C. gariepinus* can be exposed to different forms of microplastics depending on habitat conditions and local pollution sources. The differences in microplastic abundance and particle composition between pond and river samples indicate that environmental characteristics, water circulation, sediment accumulation, proximity to human activities, and aquaculture practices play important roles in determining microplastic exposure in fish. Pond environments with limited hydrodynamic exchange tend to retain particles and promote sediment accumulation, whereas river environments may facilitate downstream transport and particle redistribution.

The presence of microplastics in catfish is of ecological and food safety concern because catfish are widely consumed and may serve as a pathway for microplastic transfer along the food chain. Microplastics ingested by fish may remain temporarily in the digestive tract, be egested, or potentially interact with biological tissues depending on particle size, shape, polymer type, and residence time. Mauludy et al. (2018) stated that microplastics may pose potential health risks because particles present in the intestinal lumen can interact with biological systems through adsorption processes and may affect immune responses. In addition, smaller particles may have greater potential to translocate from the digestive tract to other tissues or organs. Although the present study focused on the digestive organs and did not evaluate microplastic transfer to edible tissues, the findings highlight the need for continued monitoring of microplastic contamination in freshwater aquaculture and riverine fish.

In summary, this study demonstrates that catfish from both pond and river environments in Sumber Agung Village were contaminated with microplastics. The pond samples showed higher total microplastic abundance, with fragments as the dominant particle type, whereas the river samples showed lower total abundance but were dominated by fibers. These findings suggest that pond environments may act as microplastic accumulation zones due to limited water circulation, sedimentation, proximity to residential activities, and aquaculture-related inputs. Meanwhile, river flow may reduce particle accumulation at a single location by transporting microplastics downstream. The results provide important baseline information on microplastic contamination in *Clarias gariepinus* and emphasize the importance of improving plastic waste management, aquaculture practices, and environmental monitoring in freshwater ecosystems.

CONCLUSION

This study demonstrates that catfish (*Clarias gariepinus*) from Station I (pond) accumulated higher levels of microplastics, with an average of 103.6 particles per individual, compared with those from Station II (river), which contained 57.6 particles per individual. The microplastics identified in catfish from both locations consisted of fibers, films, and fragments. These findings indicate that *C. gariepinus* can accumulate microplastics from both aquaculture and natural aquatic environments. Therefore, this species has potential as an early bioindicator for monitoring microplastic contamination in freshwater ecosystems.

RECOMMENDATION

This study has several limitations, particularly regarding the identification of polymer types and the analysis of the primary sources of microplastics. Therefore, future studies are recommended to conduct further analyses using polymer identification methods such as FTIR or Raman spectroscopy. In addition, microplastic concentrations in water and sediment from both sampling stations should be examined to determine the relationship between aquatic environmental conditions and the level of microplastic accumulation in fish.

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