Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 1 Issue 3 (2025)

Microplastic Contamination of Selected Fish Species

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Publication Date: April 26, 2025

Abstract

This study investigated the types of microplastics present (fibers, fragments, films) in Tilapia (Oreochromis niloticus), Galunggong (Decapterus macrosoma), and Bangus (Chanos chanos), three commercially important fish species in the Philippines, assessing how many particles are present in each. Using a descriptive research design, 90 fish samples were collected from the Tagudin Public Market in Ilocos Sur and analyzed at UP Diliman's Biological Research and Services Laboratory. Chemical digestion and stereomicroscopic examination were conducted to isolate and identify microplastics. The results revealed Tilapia has the highest number of microplastics, 98 microplastic particles, Galunggong 87, and Bangus 59. Fragments were most common in Tilapia and Galunggong, while fibers are the most abundant in Bangus. These findings highlighted habitat-specific contamination sources and underscored the potential risks of consuming fish contaminated with microplastics, which may carry toxic chemicals harmful to human health. To promote awareness, a brochure, poster, and short video were developed as part of an Information, Education, and Communication (IEC) package. Expert evaluators rated all materials as Highly Acceptable, with scores ranging from 4.1 to 4.3.

Keywords: microplastic contamination, IEC materials, food safety, Tilapia, Bangus, Galunggong

INTRODUCTION

Microplastics, defined as plastic particles smaller than five millimeters, have emerged as a significant global pollutant. They originate either directly from micro-sized products such as cosmetics (primary sources) or through the breakdown of larger plastic waste (secondary sources) (Barnes et al., 2009; Campanale et al., 2020; Cole et al., 2011). Due to their resistance to degradation, microplastics persist in aquatic environments, accumulating across marine ecosystems and entering the human food chain (Campanale et al., 2020; Cole et al., 2011).

Microplastics have been detected across all levels of aquatic life, from plankton to top predators. Marine organisms ingest them directly or through contaminated prey, enabling bioaccumulation and biomagnification of associated toxicants such as heavy metals and persistent organic pollutants (Alava, 2020; Campanale et al., 2020; Miller et al., 2020; Noman et al., 2022). Bioaccumulation refers to the buildup

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
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of contaminants within an organism, while biomagnification involves the increase of contaminant concentrations through the food chain (Miller et al., 2020; Streit, 1998).

In Southeast Asia, where marine resources are vital to food security and the economy, the issue is particularly urgent. The Philippines is among the top contributors to ocean plastic pollution, with rivers such as the Pasig serving as major conduits for plastic waste into marine environments (Deocaris et al., 2019; Jambeck et al., 2015). Given the reliance on fish in the Filipino diet, contamination can pose concerns for food safety and environmental health.

This study focuses on three key species, tilapia, galunggong, and bangus, representing freshwater, marine, and brackish habitats, respectively. By examining microplastic contamination across these species, the study aims to provide comparative insights into pollution levels across different ecosystems and contribute to understanding contamination dynamics in Philippine waters.

METHODOLOGY

1. Experimental Procedure

This study used laboratory-based analysis to detect, isolate, and classify microplastics found in the gastrointestinal tracts of the sampled fish. The key methods included chemical digestion and microscopic examination using a stereomicroscope.

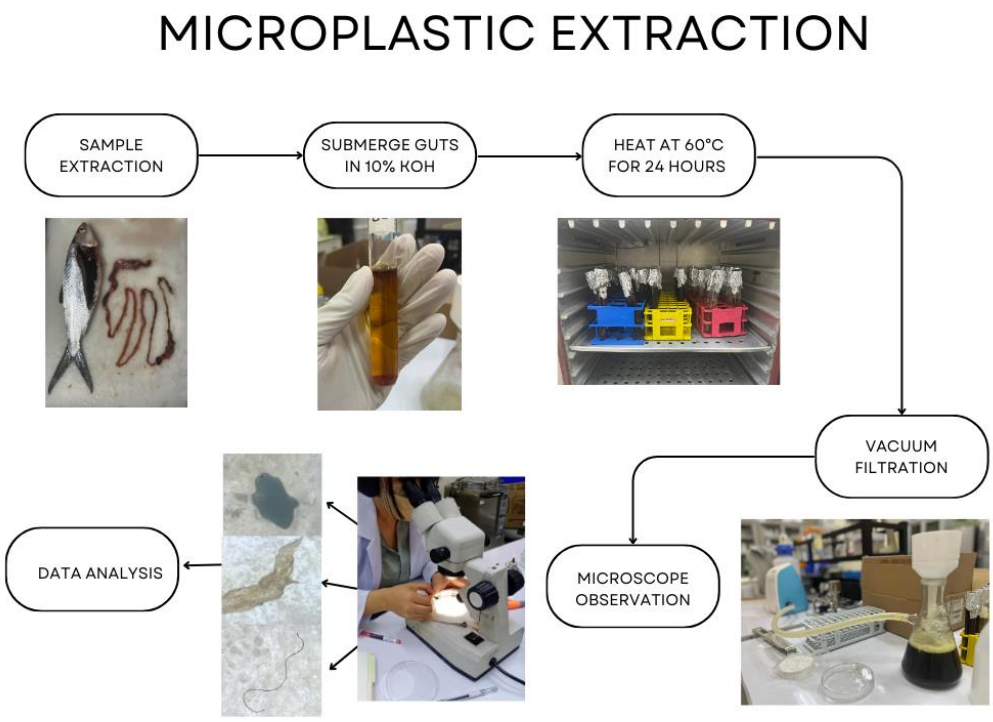

Figure 1: Microplastic Extraction Process

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Fish Sample Preparation

Each fish sample's gastrointestinal tract was isolated to focus on areas where microplastics are most likely to accumulate, as supported by findings in similar studies. This internal section provided a targeted area for analysis, given that microplastics are often found in the digestive systems of marine species.

Chemical Digestion

The microplastics are extracted from fish samples using a modified enzymatic digestion method following the procedure of (De-la-Torre et al., 2019). The collected tracts are enzymatically digested using 10% (w/v) potassium hydroxide (KOH) to degrade organic matter. The mixture was gently shaken and heated at 60 °C for 24 hours following the benchmark protocol outlined by (De-la-Torre et al., 2019).

After digestion, the supernatant solution was vacuum filtrated through a 20 – 25 µm pore Whatman filter paper. The extracted microplastics were placed in a glass petri dish for identification.

Stereomicroscopic Examination

A stereomicroscope was used to examine the filtered material for microplastic particles. The stereomicroscope, set at magnifications ranging from 40x to 100x, enabled the identification of microplastics based on their shape, color, and size. Microplastics were categorized into three types according to standard classification methods:

- Microfibers: Thin, elongated plastic fibers often originating from textiles.
- Microfragments: Small, irregularly shaped pieces of plastic, usually from degraded larger plastic objects.
- Microfilms: Thin, flat pieces often derived from plastic bags and packaging.

Each microplastic particle was documented, photographed, and categorized, with careful records kept for subsequent data analysis. The hot needle test was used to verify microplastics.

Data Analysis

The quantitative data collected from the laboratory analysis were analyzed using descriptive statistics. Data were visually presented in graphs and tables, offering an intuitive way to interpret the data and identify patterns of contamination among the different fish species.

2. Developmental Procedure

This study also employed developmental research to create an Information, Education, and Communication (IEC) package aimed at raising public awareness about microplastic contamination in fish. The key methods included the design, content development, and expert evaluation of IEC materials, ensuring clarity, accuracy, and effectiveness for Filipino consumers and policymakers.

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IEC Package Design and Content Development

The IEC package consisted of a brochure, poster, and infomercial, each designed to raise awareness about microplastic contamination. The development process involved three key phases: (1) Content Development, where parts of the research findings were translated into digestible messages for the general public; (2) Design and Layout, where visual elements were incorporated to enhance readability and impact; and (3) Preliminary Review, where initial drafts were assessed for coherence and effectiveness.

Acceptability Evaluation of IEC Materials

To assess their acceptability and effectiveness, the IEC materials were evaluated by three experts from the Bureau of Fisheries and Aquatic Resources (BFAR) and the Department of Environment and Natural Resources (DENR)using a structured questionnaire. The evaluation criteria included content, organization, mechanics, and appropriateness, rated on a 5-point scale from 1 (Fully Not Acceptable) to 5 (Very Highly Acceptable). Descriptive statistics were used to analyze the feedback, and revisions were made based on expert suggestions to enhance clarity and impact before final dissemination.

RESULTS

Microplastics in Fish

Microplastic contamination across different aquatic environments varies, as evidenced by the differences in contamination levels observed in tilapia, galunggong, and bangus. Table 1 shows that tilapia, a freshwater species, had the highest number of microplastics with a total of 98 particles, followed by galunggong, a marine species, with 87 particles, and bangus, a brackish water species, with 59 particles.

Table 1: Total Number of Microplastics Identified per Fish Species

Microplastic	**Bangus**	**Galunggong**	**Tilapia**
Fragment	20	37	50
Fiber	27	36	30
Film	12	14	18
Total	**59**	**87**	**98**

The total counts of each microplastic type are summarized in Table 2. Fragments were the most abundant overall (107 particles), followed by fibers (93) and films (44). Tilapia recorded the highest number of fragments (50), while galunggong showed nearly equal counts of fragments (37) and fibers (36). In contrast, bangus exhibited more fibers (27) than fragments (20), reflecting a different contamination pattern. Films were the least detected microplastic type across all species, with counts ranging from 12 to 18. Overall,

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fragments dominated the microplastic composition, although fibers also represented a substantial portion, especially in bangus.

Table 2: Total Count of Microplastic Types per Fish Species

Sample	Fragment	Fiber	Film
Galunggong	37	36	14
Tilapia	50	30	18
Bangus	20	27	12
Total	**107**	**93**	**44**

IEC Material Development

The evaluation results for the developed IEC (Information, Education, and Communication) materials - poster, brochure, and infomercial - are summarized in Table 3. All three were rated "Highly Acceptable" by expert evaluators based on Content and Relevance, Organization, Mechanics, and Appropriateness. The infomercial received the highest grand mean score (4.3), followed by the brochure (4.2) and the poster (4.1). These results indicate that all materials met quality and effectiveness standards as assessed by professionals from BFAR and DENR.

Table 3: IEC Material Evaluation Summary

IEC Material	Grand Mean	Interpretation
Poster	4.1	Highly Acceptable
Brochure	4.2	Highly Acceptable
Infomercial	4.3	Highly Acceptable

DISCUSSION

Microplastic Contamination in Fish

Tilapia exhibited the highest number of microplastics among the three fish species analyzed. A feasible explanation for this trend is the nature of freshwater ecosystems, which are more directly exposed to localized pollution sources. Urban runoff, industrial effluents, and insufficient waste management contribute significantly to the accumulation of plastics in freshwater environments (Bhardwaj et al., 2024; D'Avignon et al., 2022). Unlike marine systems, freshwater bodies typically have lower water exchange

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Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
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rates, resulting in longer retention times for plastic debris and greater opportunities for microplastic ingestion by resident species.

Tilapia also recorded the highest number of microplastic fragments, accounting for more than half of the particles detected in this species. This suggests that tilapia are heavily exposed to the secondary breakdown products of larger plastic waste items such as bags, containers, and other consumer materials. Fragmented plastics dominate in areas with significant human activity, where larger debris undergoes photodegradation and mechanical abrasion (Oza et al., 2024; Talbot & Chang, 2022). The dominance of fragments in tilapia is consistent with previous findings that species feeding near the bottom or within sediments are more likely to ingest degraded plastic particles embedded in the substrate.

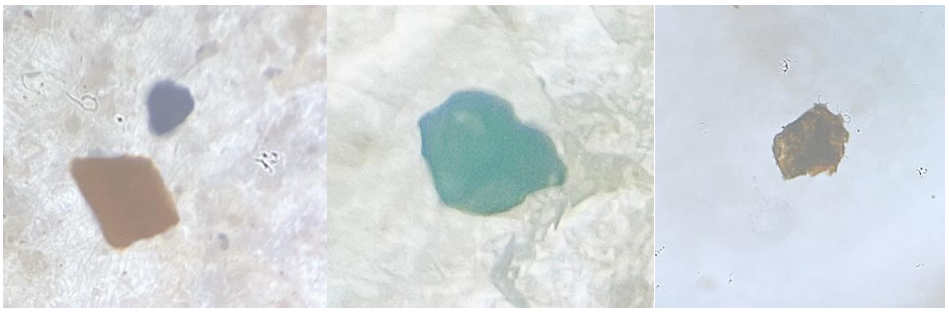

Figure 2: Microfragments

Galunggong, a marine species, exhibited a slightly lower overall number of microplastics but showed an almost balanced presence of fragments and fibers. This pattern reflects the complexity of marine plastic pollution dynamics. Marine environments are influenced by wide-ranging factors, including the transport of plastics via ocean currents, atmospheric deposition, and offshore waste dumping (Cole et al., 2011; Yang et al., 2021). Galunggong's contamination suggests exposure both to floating debris and to prey items contaminated with microplastics, a phenomenon known as trophic transfer. Studies have highlighted how microplastics can move up the food chain, from plankton to small fish, and then to larger pelagic species like Galunggong (Ashrafy et al., 2023; Lusher, 2015).

The nearly equal distribution of fragments and fibers in galunggong further indicates that multiple sources contribute to contamination. Fragments likely originate from the breakdown of ocean-surface plastics, while fibers are often introduced through domestic and industrial wastewater discharges entering coastal waters.

Bangus, found in brackish estuarine habitats, showed the lowest overall microplastic count among the species studied. However, unlike tilapia and galunggong, bangus exhibited a distinct contamination profile dominated by fibers rather than fragments. This result may be explained by the mixing dynamics of estuarine environments, where freshwater and saltwater converge. Flocculation processes cause suspended particles, including microplastics, to aggregate and settle into sediments, reducing the number of floating particles available for pelagic feeders like bangus (Laursen et al., 2023).

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Figure 3: Microfibers

The dominance of fibers in bangus suggests a significant influence from land-based textile sources. Fibers are commonly released during washing machine cycles and are transported through sewage systems into aquatic environments (Upadhyay et al., 2024). As these fibers tend to settle with fine sediments, bottom-feeding or filter-feeding species such as bangus are more likely to ingest them.

The consistent detection of films across all three species, albeit at lower levels, highlights the ongoing contribution of plastic bags, wrappers, and other thin-sheet plastics to aquatic pollution. Although films are lighter and more likely to fragment rapidly, their initial presence in the environment remains a persistent problem.

Figure 4: Microfilms

Overall, the patterns observed in this study support the hypothesis that microplastic contamination varies according to species habitat, feeding behavior, and proximity to pollution sources. Freshwater species like tilapia are heavily exposed to fragments from direct land-based pollution. Marine species like galunggong experience complex contamination from dispersed debris and trophic pathways. Estuarine species like bangus show localized contamination patterns heavily influenced by textile fibers.

These results emphasize the intricate relationship between aquatic habitat characteristics and the type and extent of microplastic exposure. They also reinforce the broader understanding that plastic pollution is not uniform across environments but shaped by human activity patterns, hydrodynamic conditions, and species-specific behaviors.

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IEC Material Evaluation

The development and evaluation of the IEC (Information, Education, and Communication) materials – poster, brochure, and infomercial – demonstrate the importance of strategic communication tools in addressing environmental challenges like microplastic pollution. The results indicated that all three materials were rated "Highly Acceptable" by expert evaluators.

Figure 5: Infomercial

The infomercial, which achieved the highest evaluation score, highlights the effectiveness of multimedia approaches in simplifying complex scientific information and making it accessible to a wide audience. This finding aligns with previous research demonstrating that short educational videos significantly improve knowledge retention and audience engagement, especially for topics related to environmental and public health issues (Doheny et al., 2023; Pop et al., 2023).

The brochure, on the other hand, proved effective in presenting information with sufficient depth while maintaining reader accessibility. This format allows for more detailed explanations compared to posters, emphasizing the role of brochures in bridging scientific concepts to public audiences in environmental education campaigns.

Figure 6: Brochure

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The poster, while scoring slightly lower than the other two formats, still met the criteria for Highly Acceptable materials. Posters are designed to deliver key messages quickly through visual impact, and the positive evaluation suggests that the poster successfully fulfilled this role. Posters are valuable in capturing attention and initiating awareness, even if they provide less depth compared to other media.

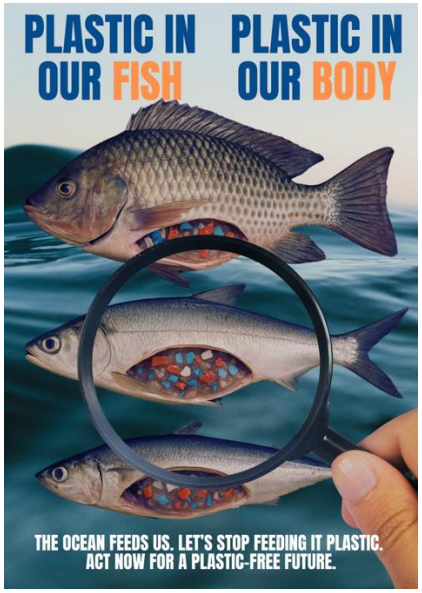

Figure 7: Poster

Across all materials, high scores for Content and Relevance, Organization, Mechanics, and Appropriateness confirm that the IEC package effectively communicated the issue of microplastic contamination. The combination of visual, textual, and multimedia formats offered diverse modes of engagement, increasing the likelihood that the intended messages would reach and resonate with different audience segments.

As microplastic pollution continues to be a growing concern worldwide, the availability of clear, accessible, and engaging educational tools can play a vital role in enhancing public understanding, shaping positive environmental behaviors, and encouraging community action.

CONCLUSION

This study identified and analyzed microplastic contamination in tilapia, bangus, and galunggong to assess the extent of pollution and its potential environmental and human health impacts. Fragments, fibers, and films were found in all three species, with tilapia showing the highest contamination, particularly from fragments; galunggong exhibited a balanced distribution of fragments and fibers, while bangus had a higher presence of fibers, suggesting that habitat and feeding behaviors influence contamination patterns. To raise public awareness, an Information, Education, and Communication (IEC) package consisting of a poster, brochure, and infomercial was developed, emphasizing accessibility and clarity. Expert evaluation by

BFAR and DENR rated the materials as Highly Acceptable, citing strengths in content relevance, clarity, and visual appeal.

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