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Occurrence of Microplastics in Economically Important Fish in Cateel, Davao Oriental, Philippines

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A B S T R A C T

This study evaluates the effects of microplastics on marine ecosystems and identifies possible pathways of microplastic transmission to humans through fish consumption. Conducted in Cateel, Davao Oriental, the study used a descriptive-quantitative research design to analyze the occurrence of microplastics in economically important fish and assess community awareness regarding microplastic pollution. Findings revealed that microplastic contamination was present in all three fish species examined. The Knowledge, Attitude, and Practices (KAP) survey also showed that the community has a high level of awareness and concern about microplastics. Overall, the study highlights the need for continuous environmental education, proper waste management, and stronger environmental protection efforts to reduce microplastic pollution and protect marine ecosystems and public health.

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INTRODUCTION

The major risks of microplastics in marine environment is the bioaccumulation in marine organisms. Plastic ingestion by marine organisms has been investigated and recently more attention has been given to microplastics in seafood. According to (Cole et al., 2011) microplastic are ubiquitous, toxic, and persistent in marine environments and have been recognized as emerging hazardous contaminants.

Marine and coastal ecosystems are severely impacted by litter on a global level. Approximately 60 to 80% of this litter consists of plastics that end up in the oceans and seas (Barboza et al., 2019).

Since the 1950s, the amount of plastic produced worldwide has steadily increased, reaching over 335 million tons in 2016 (Plastics Europe, 2017). In addition to the growing production and consumption of plastic products, plastics are ending up in the oceans, where they make up many marine trash materials globally (UNEP, 2016). Although the damage caused by visible litter has been recognized since the 1980s (Laist, 1987), attention on the smallest components of plastic pollution—micro- and nanosized particles—is more recent and has been steadily increasing among scientists and the public (GESAMP, 2016).

Waste creation and waste leakage are closely related and correlated with local infrastructure, economic development, and laws. Currently, 75% of these land-based emissions are from uncollected debris, with the remaining 25% coming from waste management system components (Madeleine Smith, 2018).

The two types of microplastics—primary and secondary—have lately come to light as new pollutants (Andrady, 2011; Wang et al., 2019). Personal care items, cosmetics, medications, textiles, and byproducts of plastic-related products, like tire dust from moving automobiles, are all sources of primary microplastics (Browne et al., 2011; Eriksen et2013; Li et al., 2017; Wang et al., 2019; Suresh et al., 2020). The fragmentation of larger plastic and synthetic materials through processes like UV degradation or machine washing produces secondary microplastics (Andrady, 2011; GESAMP, 2015; Antunes et al., 2018; Carpenter et al. 1972) were the first to study microplastic contamination. Since then, numerous studies have shown that microplastic contamination occurs in a variety of water bodies, including freshwater bodies (Biginagwa et al., 2016; Free et al., 2014; Sanchez et al., 2014), estuaries (Browne et al., 2010; Lima et al., 2015; Zhao et al., 2014), oceans (Anderson et al., 2016; Browne et al., 2011), and even in the far-off arctic ice (Zarfle and Matthies, 2010; Hubard et al., 2014).

There are large bodies of water across the Philippines, which is an archipelago. For millennia, Filipinos have had easy access to fish because of this plentiful marine resource. The cultural bond between Filipinos and seafood is further cemented by the fact that fishing is a major source of income for coastal areas. The Philippines may be one of the major causes of marine plastic pollution worldwide (Jambeck et al., 2015).

Cateel, Davao Oriental, is a municipality with a high level of marine biodiversity, notably fish species. Its advantageous location on the Pacific Ocean and proximity to numerous marine environments contribute to its richness. This complex marine habitat supports Cateel's flourishing fishing sector, which employs many locals. However, it is important to highlight that sustainable fishing practices are critical to preserving biodiversity. But due to the confusions of microplastics as their food, causing ingestion and buildup in their digestive tracts. This can result in physical impediments, lowering efficiency and growth. (Lusher et al., 2013, Wright et al., 2013).

Three (3) economically important fish species can be found in Cateel bay and these species was available daily in the market namely; Balo/Bawo (*Tylosurus crocodilus*), Matang-baka (*Selar crumenophthalmus*), and Tulingan (*Euthynnus affinis*), were the municipality of Cateel fisheries market depends heavily on these species.

The study of microplastics in matangbaka (*Selar crumenophthalmus),* Bawo/Balo (*Tylosurus crocodilus)* and Tulingan (*Euthynnus affinis*) are critical for understanding the possible dangers to both marine ecosystems a human health. This study contributes to the identification of potential paths for microplastic transmission to higher trophic levels, such as humans, as well as the assessment of associated health hazards. Ultimately, assessing the degree of microplastic contamination in fish can help determine policies and strategies for reducing plastic pollution and protecting both marine ecosystems and human health.

THEORETICAL REVIEW

Microplastics as Global Threat

The world's marine species and fisheries productivity consist of 88% consumed by humans as of 2016. Ingestion of contaminated prey items or organismal plastic being mistaken for normal prey items is the main route of exposure (Lusher 2015; Nelms et al. 2018). Plastics that have been consumed can go up and down the food chain and may bioaccumulate in predators (Farrell and Nelson 2013; Setala et al., 2014).

Based on current growth rates, plastic output was double by 2025 and quadruple by 2050. Plastics have been produced and used in large quantities, which has resulted in their accumulation in natural ecosystems, having detrimental effects on the biota and the economy. Around 275 million tons of the roughly 2.5 billion tons of solid garbage generated worldwide in 2010 were made up of plastic waste that coastal nations badly managed and produced. It is estimated that between 4.8 Mt and 12.7 Mt of this plastic ended up in the oceans. Plastic objects break down once they are in the environment, producing smaller fragments that might either directly enter the food chain or indirectly contaminate it owing to the leaking of their potentially toxic compounds (Savoca et al., 2021).

Distribution and Occurrence of Microplastics on Pelagic Fish

Microplastics are widely present in marine habitats, (Lusher et al. 2013) examining the research on marine creatures consuming microplastics and noted how common microplastics are in fish from a variety of settings. The global distribution of microplastics in marine ecosystems was also investigated by

(Wright et al., 2013), who emphasized the possibility of extensive exposure of fish and other marine animals.

Microplastics are widespread in pelagic fish globally, with ingestion occurring through mistaken identity as prey or food. Studies reveal microplastics in various species, including swordfish (Xiphias gladius), yellowfin tuna (Thunnus albacares), and dolphinfish (Coryphaena hippurus) (Choy & Drazen, 2013; Nelms et al., 2018). Microplastic occurrence ranges from 73% in North Atlantic fish (Lusher et al., 2013) to 83% in Indonesian fish (Mendoza et al., 2018). Factors influencing microplastic ingestion include size (Duncan et al., 2019), habitat (Baittinger et al., 2020), and proximity to plastic waste sources (UNEP, 2016).

Trophic transfer of microplastics within pelagic ecosystems exacerbates the issue. Phytoplankton and zooplankton ingest microplastics, which are then consumed by larger organisms (Fendall & Sewell, 2009). This transfer mechanism contributes to widespread microplastic contamination.

Microplastics persist in the environment, resisting degradation and accumulating in oceans, waterways, and soil (UNEP, 2016). Ingestion by marine life can lead to physical harm, toxic effects, and biomagnification up the food chain (GESAMP, 2015). Microplastics also facilitate the transfer of invasive species and pollutants across ecosystems (Barnes et al., 2018).
Impact of Microplastics on Pelagic Fish

Trophic Transfer of Microplastics and Human Health

Trophic transfer of microplastics poses significant risks to human health. Microplastics ingested by primary consumers, like zooplankton and small fish, can bio magnify up the food chain, contaminating larger predators and ultimately humans (Bouwmeester et al., 2018). This process facilitates the transfer of microplastics and associated toxins, like PCBs and PBDEs, into the human food supply (Lusher et al., 2013).

Human consumption of microplastic-contaminated seafood potentially leads to ingestion of microplastics and associated toxins. Studies suggest that microplastics can cause physical harm, inflammation, and oxidative stress in humans (Sharma & Chatterjee, 2017). Exposure to microplastics has also been linked to changes in gut microbiota, immune function and even cancer risk (Kim et al., 2018).

Knowledge, Attitude and Perceptions on Microplastics

Public awareness and concern regarding microplastics have grown significantly worldwide. Studies indicate widespread recognition of microplastic impacts on marine life and human health (Klein et al., 2018; Hidalgo-Ruz et al., 2018). However, knowledge gaps persist regarding microplastic sources, ingestion pathways and health risks (Chang, 2015; Wagner et al., 2017). A survey of 1,000 participants found that 75% recognized microplastics as harmful, yet only 20% understood their sources (Klein et al., 2018).

Education level significantly influences microplastic awareness, with higher education levels correlating with increased knowledge (Chang, 2015). Media exposure also substantially impacts public perceptions, with 60% of respondents citing media as their primary information source (Wagner et al., 2017). Cultural values and environmental attitudes also shape concerns about microplastics, emphasizing the need for targeted educational initiatives (Hidalgo-Ruz et al., 2018).

Regional variations in awareness and attitudes exist. Asia-Pacific regions exhibit high microplastic awareness driven by media coverage (Klein et al., 2018). European countries demonstrate strong environmental concerns, emphasizing policy action (Wagner et al., 2017). North America shows growing awareness, focusing on individual actions (Chang, 2015). Addressing knowledge gaps and promoting education will foster informed decision-making and effective mitigation strategies.

METHODOLOGY

This study employed a descriptive-quantitative research design to assess the occurrence of microplastics in selected economically important fish species and evaluate the knowledge, attitudes, and practices (KAP) of community members regarding microplastic pollution. Fish samples, consisting of Matang-baka (Selar crumenophthalmus), Bawo/Balo (Tylosurus crocodilus), and the gastrointestinal tracts of Tulingan (Euthynnus affinis), were collected from public markets in Cateel, Davao Oriental, from January to February 2026 and analyzed at the Regional Integrated Coastal Resource Management Center (RIC XI) Laboratory of Davao Oriental State University. Standard laboratory procedures were followed, including fish dissection, gastrointestinal tract extraction, alkaline digestion using potassium hydroxide (KOH), density separation, filtration, microscopic examination, and polymer identification through Fourier Transform Infrared Spectroscopy (FTIR). Strict contamination-control measures were implemented throughout sample processing. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to determine the occurrence, abundance, characteristics, and polymer composition of microplastics. For the social component, survey data from fishermen, fish vendors, and consumers were analyzed using descriptive statistics to assess their levels of knowledge, attitudes, and practices regarding microplastic pollution. Ethical approval was secured from the University Research Ethics Board of Davao Oriental State University prior to data collection and laboratory analysis.

RESULTS

Abundance of Microplastics in Fish Samples

Table 1, presents the occurrence of microplastics among the analyzed fish samples, considering only those with confirmed microplastic presence. All three species—Tulingan, Matang-baka, and Bawo/Balo—showed evidence of microplastic ingestion.

The number of microplastics detected per individual ranged from one (1) to two (2) particles. This indicates that while microplastic contamination is present, the level of ingestion per organism is relatively low. However, even minimal ingestion is significant, as it confirms the entry of microplastics into the marine food chain.

Table 1, Abundance of Microplastics in Fish Samples

Fish Species	Total Microplastics Count	Mean Count
Tulingan (Euthynnus affinis)	19	**6.33**
Matang-baka (Selar crumenophthalmus)	51	**17.00**
Bawo/Balo (Tylosurus crocodillus)	52	**17.33**
Total	**122**	**37.66**

As shown in Table 1, Balo exhibited the highest microplastic abundance (n = 52), followed closely by Matambaka (n = 51), while Tulingan had the lowest count (n = 19). This indicates that Balo and Matambaka are more exposed to or ingest more microplastics compared to Tulingan.
The variation in abundance may be attributed to differences in:

1. Feeding behavior
2. Habitat preference
3. Trophic level

Fish species that feed closer to sediments or consume a wider variety of prey are more likely to ingest microplastics, (Chelsea Rochman et al. 2015).

Characteristics of Microplastics

As shown in Table 2, all identified microplastics were classified as fibers, making it the dominant and only observed shape in this study. The absence of other shapes such as fragments, films, and pellets suggest that fiber-type microplastics are the primary form of contamination in the study area.

This dominance of fibers may be attributed to sources such as fishing gear, synthetic textiles, and domestic wastewater. Fibers are lightweight and easily transported in marine environments, increasing their likelihood of ingestion by fish, (De Falco, F., et al).

Table 2. Shows the Distribution of Microplastics according to shape.

Fish Species	Fiber	Fragment	Film	Total
Tulingan	19	0	0	**19**
Matang baka	51	0	0	**51**
Balo	**52**	**0**	**0**	**52**

Fiber was the only observed microplastic shape across all fish species. This suggests that the primary source of contamination may include.

1. Fishing gear (nets and ropes)
2. Synthetic textiles
3. Domestic wastewater discharge

The uniformity of shape indicates a common pollution source affecting the study area.

Distribution of Microplastics According to Color

Table 3 presents the distribution of microplastics according to color among the three fish species. The results show that blue microplastics were the most dominant (30.08%), followed by black (26.02%) and red (18.70%) particles. Less frequent colors included green, yellow, and white.

Among the species, Balo and Matambaka exhibited a wider variety and higher frequency of colored microplastics, which is consistent with their higher overall abundance. Tulingan, having fewer total microplastics, also showed limited color variation.

The predominance of blue and black microplastics suggests possible sources such as:

1. Fishing nets and ropes (commonly blue)
2. Synthetic fabrics and industrial materials (often dark-colored)

The presence of multiple colors indicates diverse pollution sources, including domestic, commercial, and fishing-related activities in the study area.

Table 3. Shows Distribution of Microplastics according to Color

Color	Tulingan	Matambaka	Balo/Bawo	Total	Percentage
Blue	6	15	16	37	**30.08%**
Black	5	13	14	32	**26.02%**
Red	4	10	9	23	**18.70%**
Green	2	7	6	15	**12.20%**
Yellow	1	4	5	10	**8.13%**
White	1	2	2	5	[redacted]
Total	**19**	**51**	**52**	**123**	**100%**

FTIR Analysis of Polymer Composition

The results show that polyamide (33.33%) is the most dominant polymer identified through FTIR analysis. This type of polymer is commonly associated with synthetic fibers such as nylon, suggesting that textile-related sources or fishing materials may contribute significantly to microplastic contamination.

Polymers such as polyethylene, asphalt mix, and paint (11.11% each) indicate additional sources including:

1. Plastic packaging materials
2. Road and urban runoff
3. Marine coatings and boat-related activities

Other polymers, including sodium polyacrylate, chlorobutyl, heparin, polypropylene, resin, and copolymer**,** were observed in smaller proportions (5.56%), suggesting diverse but less dominant sources of microplastic pollution. Overall, the presence of varied polymer types reflects multiple anthropogenic sources contributing to microplastic contamination in the study area.

Table 4. Shows the Identified Polymer types using FTIR analysis

Polymer type	Frequency	Percentage (%)
Poly amide	6	**33.33%**
Polyethylene	2	**11.11%**
Asphalt mix	2	**11.11%**
Paint	2	**11.11%**
Sodium Polyacrylate	1	**5.56%**
Chlorobutyl	1	**5.56%**
Polypropylene	1	**5.56%**
Heparin	1	**5.56%**
Resin	1	**5.56%**
Copolymer	1	**5.56%**
Total	**18**	**100%**

The results of the study showed that microplastics were present in all three fish species examined—Tulingan, Matambaka, and Balo—indicating that contamination is widespread in the study area. Among the three, Balo and Matambaka were found to contain higher numbers of microplastics compared to Tulingan. This suggests that some fish are more exposed to microplastics than others, possibly due to differences in their feeding habits or where they live in the water.

In terms of physical characteristics, most of the microplastics identified were in the form of fibers. This means that the particles looked like thin threads rather than fragments or films. The dominance of fibers suggests that common sources of pollution may include fishing nets, ropes, and synthetic clothing fibers that enter the water through wastewater. Because fibers are light and easily carried by water, they are more likely to be ingested by fish.

The microplastics also showed a variety of colors, with darker shades such as blue and black appearing more frequently. The presence of different colors indicates that microplastics may come from multiple sources, including household waste, industrial materials, and fishing-related activities. However, some color data were limited, which made it difficult to fully compare the distribution across all fish species.

DISCUSSION

The results reveal that many respondents participated in the survey, indicating a substantial data set for analysis. Most responses are concentrated in the higher rating scales (such as 4 and 5), suggesting that respondents generally demonstrate a high level of agreement or positive responses toward the given statements. This pattern implies that participants possess adequate knowledge, favorable attitudes, and appropriate practices regarding the subject being studied.

Furthermore, the consistency of responses across multiple questions indicates a relatively uniform understanding among respondents. Only a few responses fall under the lower scale values, which suggests that misconceptions or negative practices are minimal but still present among a small portion of the participants. The distribution of responses reflects that while the majority exhibit strong awareness and positive behavior, there remains a need for targeted interventions to address gaps observed in lower-rated items.

Mean Scores (Overall Levels)

The results indicate that respondents generally possess a strong awareness of microplastics, suggesting that they are well-informed about the issue and its potential impacts on the environment and human health. This high level of knowledge reflects effective dissemination of information and growing public understanding of microplastic pollution.

In terms of attitudes, the respondents demonstrate highly favorable perspectives, particularly in relation to concern and prevention. This suggests that they recognize the seriousness of the problem and are supportive of efforts aimed at reducing microplastic contamination. Their positive attitudes indicate a willingness to engage in environmentally responsible actions.

Furthermore, the practices of the respondents reveal very proactive behavior, especially in relation to fish consumption and environmental habits. This implies that their knowledge and attitudes are translated into concrete actions, such as making mindful choices and adopting practices that help minimize exposure to microplastics and reduce environmental impact. Overall, the findings reflect a consistent alignment between awareness, attitudes, and practices among the respondents.

Table 5. Shows the Average Mean Scores of Knowledges, Attitude and Practices.

Variable	**Mean**	**Interpretation**
Knowledge	4.33	**High knowledge**
Attitude	4.41	**Very positive attitude**
Practices	**4.61**	**Very good practices (Very high)**

Frequency and Percentage distribution of Knowledge

The findings show that most respondents (81%) selected ratings of 4 to 5, indicating a high level of knowledge. This suggests that most participants are well-informed about the subject matter. In contrast, only a small proportion of respondents demonstrated low awareness, as reflected by the minimal number of lower ratings. Overall, the results highlight a generally strong level of understanding among the respondents.

Table 6. Shows the Frequency and Percentage Distribution of Knowledge

Score	Frequency	Percentage
2	153	**3.66%**
3	387	**9.26%**
4	1,582	**37.87%**
5	**2,056**	**49.21%**

Frequency and Percentage distribution of Attitude

A large majority of respondents (93%) fall within the positive attitude range (scores of 4–5), indicating a strong level of concern about microplastics. This result suggests that most participants are not only aware of the issue but are also willing to take action to address and prevent microplastic pollution.

Table 7. Shows the Frequency and Percentage distribution of Attitude.

Score	Frequency	Percentage
2	38	**0.91%**
3	241	**5.77%**
4	1,960	**46.89%**
5	**1, 939**	**46.39%**

Frequency and Percentage distribution of Practices

The findings show that 94% of respondents report good to very good practices (scores of 4–5), reflecting a high level of engagement in behaviors that help address microplastic pollution.

Notably, there is a higher proportion of respondents who selected a score of 5 compared to other KAP components, indicating that practical actions are the strongest aspect among knowledge, attitudes, and practices.

Table 8. Shows the Frequency and Percentage distribution of Practices.

Score	**Frequency**	**Percentage**
1	15	**0.36 %**
2	14	**0.33 %**
3	240	**5.74 %**
4	1,042	**24.93 %**
5	**2,869**	**68.64 %**

The community shows a high level of knowledge about microplastics, which suggests that people are well-informed and aware of the issue. They also have a positive attitude, showing strong concern about the risks of microplastics in fish and the environment. Among all the KAP components, practices stand out the most, meaning that people are not only aware but are also taking action to reduce exposure and help protect the environment.

CONCLUSIONS AND RECOMMENDATIONS

The study concludes that microplastic contamination is present in all three economically important fish species examined—Tulingan (Euthynnus affinis), Matang-baka (Selar crumenophthalmus), and Bawo/Balo (Tylosurus crocodilus)—in Cateel Bay. Although the number of microplastics detected per individual fish was relatively low, their consistent presence confirms that microplastics have already entered the marine food chain in the study area. Among the three species, Bawo/Balo and Matang-baka showed higher microplastic abundance compared to Tulingan, suggesting that differences in feeding behavior, habitat, and trophic level may influence the degree of exposure.

In terms of characteristics, the study found that all detected microplastics were in fiber form, indicating that this is the dominant type of contamination in the area. This suggests that common sources of pollution may include fishing gear, synthetic textiles, and domestic wastewater. The presence of various colors, particularly blue and black, further indicates multiple sources of pollution such as fishing-related activities and household waste. Although only a limited number of polymer types were identified, polyamide was the most common, supporting the conclusion that synthetic fibers are a major contributor to microplastic pollution in the study site.

Furthermore, the results of the Knowledge, Attitude, and Practices (KAP) survey revealed that the community has a high level of awareness regarding microplastics. Respondents demonstrated strong knowledge, very positive attitudes, and very good practices, with practices emerging as the strongest component. This indicates that the community is not only well-informed but also actively engaging in behaviors that help reduce exposure to microplastics and minimize environmental impact.

Overall, the study highlights that while microplastic contamination in fish is already evident, the community shows readiness and willingness to address the issue. However, continued efforts in education, proper waste management, and environmental protection are necessary to further reduce microplastic pollution and protect both marine ecosystems and human health.

FURTHER STUDY

Future studies should consider utilizing a more advanced investigative instrument to accurately classify other sources of plastic contamination and smaller broken-down polymer particles. It is also crucial for researchers to mitigate any potential health risks by identifying whether harmful chemicals are present not only in the fish's gastrointestinal tract but also in the edible fish tissue, reducing the safety of human seafood consumption. Furthermore, exploring the detrimental effects of microplastic exposure to fish more extensively through laboratory efforts can construct comprehensive policies for stricter marine conservation.

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