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EVALUATING THE IMPACT OF MICROPLASTICS ON *Catla catla* IN POND WATERS OF SARGODHA USING FTIR SPECTROSCOPY

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ABSTRACT

Microplastics-pieces of plastic smaller than 5 millimeters-are now seen as a serious pollutant in freshwater systems, especially in aquaculture ponds. This study looks at how many of these tiny particles are floating in the water around Sargodha, Pakistan, and whether they end up in the meat of *Catla catla*, a popular local fish. Most scientific attention has gone to oceans, leaving little information about South Asian freshwater farms. Earlier work has shown that microplastics can hurt habitats, throw off food webs, and carry harmful chemicals. By studying area ponds, this project begins to fill that knowledge hole and shows what the pollution could mean for people who eat the fish. To gather data, researchers took water and fish samples from five ponds-Chak No. 36, Chak No. 39, Chak No. 94, Chak No. 98, and Chak Asian Wala Gaoun-while following strict steps to avoid outside contamination. Experts then used FTIR (Fourier Transform Infrared) spectroscopy to sort different plastics and confirm how many particles were in the water and in fish tissue. FTIR readings highlighted the uniform presence of polyethylene, polypropylene, polystyrene, and polyethylene terephthalate in every sample tested. Fish meat contained more fragments and a wider mix of plastics than the surrounding water, pointing to bioaccumulation and potential travel up the food chain. Peak intensity and placement differed from one site to another, with Chak No. 36 expressing the heaviest burden.

INTRODUCTION

Microplastics—defined as plastic particles smaller than five millimeters—are increasingly recognized as a significant pollutant not only in marine but also freshwater ecosystems. These particles originate from multiple sources, including the breakdown of plastic bags and bottles, fiber shedding from synthetic textiles during laundering, industrial activities, and runoff from agricultural lands (Du et al., 2021; Uwamungu et al., 2022). Once in aquatic systems, microplastics can be ingested by a wide range of organisms, disrupting trophic interactions and transferring toxic substances through the food web. This is particularly concerning in regions lacking robust waste management and environmental monitoring systems (Iftikhar et al., 2025; Bilal et al., 2025).

Sargodha, one of the most important agricultural districts in Punjab, Pakistan, exemplifies the increased risk of microplastic pollution from urban expansion and increased agricultural intensification. Despite being famous for its kin now citrus exports, Sargodha has rapidly urbanizing population and plastic pollution from agricultural uses (e.g. mulching films and packaging) threaten the environment (Ahmad, 2019; Farooq et al., 2023). The local water bodies are also used for both irrigation and aquaculture meaning the potential for microplastics to enter the food chain increasingly exist (Shahin et al., 2024; Sattar et al., 2024).

Catla catla (Thela), a fish that is commonly farmed in Sargodha, directly exposed to pond water containing microplastics. Existing literature has noted that fish can experience intestinal impairment, endocrinological difficulty, and bioaccumulation of pollutants such as heavy metals as a result of microplastic consumption (Erdoğan, 2020; Garai et al., 2021). These hazards can, in turn, be transferred to humans following fish consumption (Yuan et al., 2022). This study aims to evaluate the presence of microplastics and their impacts on the aquaculture systems in Sargodha using FTIR analysis with the hope of generating recommendations that are based on data to limit pollution.

Materials and Methods

Study Location

The research study involved three fish ponds, located in Sargodha, Pakistan. Pond A was comprised of agricultural runoff, Pond B was associated with urban wastewater, and Pond C contained fertilizer and litter. All ponds cultured *Catla catla*. The diverse sources of pollution exemplified localized microplastics hazards to freshwater ecosystems and safe food in the area.

Data Collection Design

Data was collected in June to July, during the period of highest activity for *Catla catla* fish to allow maximum potential for microplastic detections. Samples included different zones of the pond to better reflect the environment (Akhter & Panhwar, 2022). Fish were humanely euthanized using a method utilizing ice-water. Field blanks and sterilized supplies were used to limit contamination, following Munno et al. (2023) and Forrest et al. (2019).

Water Sampling Protocol

Water samples were taken, using pre-cleaned 1-liter glass jars, from five ponds—Chak No. 36, 39, 94, 98, and Asian Wala Gaoun—all of which are subject to agricultural runoff or urban waste. The samples were collected 20 cm below the surface to purposefully reach the primary photic zone where *Catla catla* is known to feed and plastics are more likely to accumulate (Zhang et al., 2021). A total of 60 samples were gathered systematically. Samples were stored in dark coolers at 4°C (Rolf et al., 2024), with blanks used to detect airborne contamination. Only glass or metal tools were used, and metadata were recorded (Feng et al., 2019).

Fish Sampling Protocol

Fish samples were collected from five aquaculture sites—Chak No. 36, 39, 94, 98,

and Asian Wala Gaoun—using gill nets during peak morning feeding hours (06:00–09:00), targeting ten *Catla catla* (16–24 cm) per site (Badola et al., 2023). Fish were immediately placed in sealed, ice-cold containers (4°C) to preserve tissue freshness (Smith et al., 2018). Only dorsal muscle was extracted, avoiding internal organs, as it is the part commonly consumed (Arshad et al., 2023). Tools were metal, surfaces sterilized with ethanol, and samples frozen in glass at -20°C.

Laboratory Analysis

Muscle tissues were digested using 35% H_2O_2 with Fenton's reagent at 50°C for 24 hours, followed by NaCl-based density separation, centrifugation (3,000 rpm), and filtration through 0.45 µm cellulose nitrate filters. Filters dried at 40°C; pre-combusted glassware and blanks ensured reliability. Polymer recovery exceeded 90%, confirming method accuracy.

Microplastic Identification

Microplastics were sorted under a stereomicroscope (40–100x) by shape, size (<5 mm), and color to infer sources (Süssmann et al., 2021). Polymer types were confirmed using ATR-FTIR spectroscopy against the Hummel and Know-it-all libraries (≥70% match; Lusher et al., 2020). Micro-FTIR analyzed particles <20 µm (Prata et al., 2019).
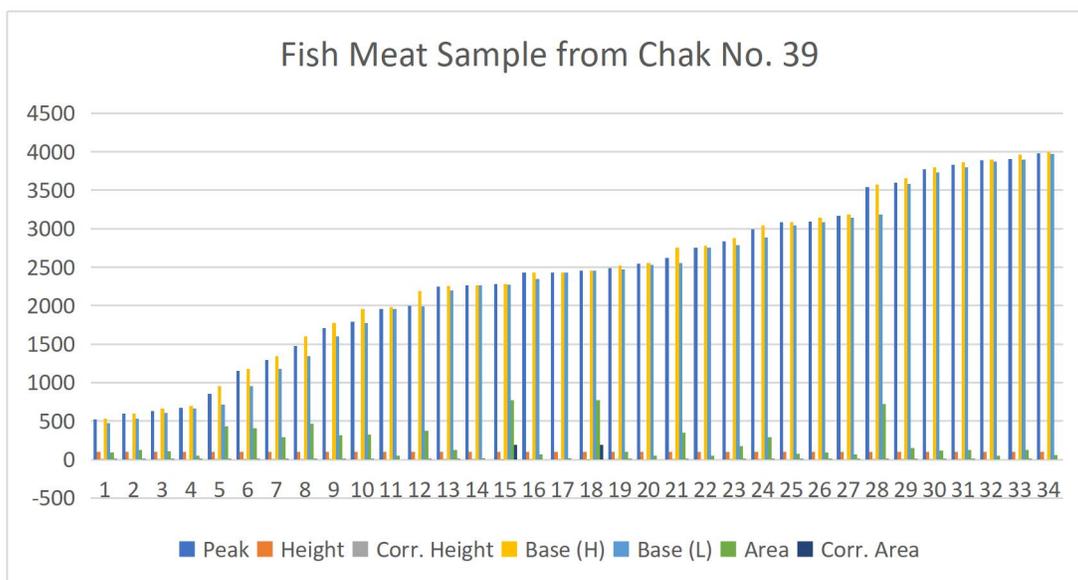
RESULTS AND DISCUSSION
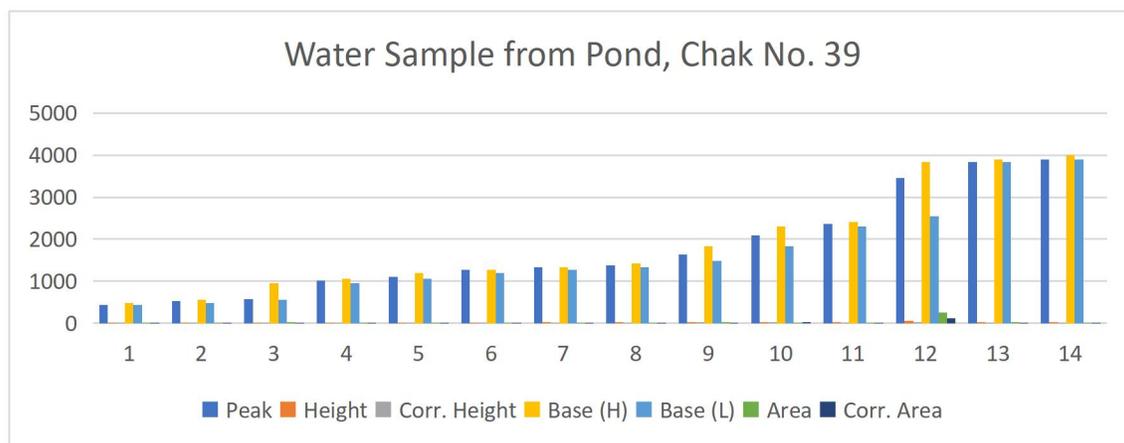
Figure 1: Bar Graph of Water Sample from Pond, Chak No. 39

The water sample from Pond, Chak No. 39 shows multiple peaks, indicating the presence of various substances. The highest peak suggests a dominant contaminant or compound, while the varying heights and areas of other peaks imply a mix of additional components. Further analysis is needed to identify specific contaminants and their concentrations.

Figure 2: Bar Graph of Fish Meat Sample from Chak No. 39

Figure 2, the mass spectrometry results of the fish meat sample (Chak No.39) show several peaks, each representing a different compound. The heights and areas between these peaks suggest differing concentrations or compositions in the various substances present. Further analyses are needed to identify these constituents or contaminants.
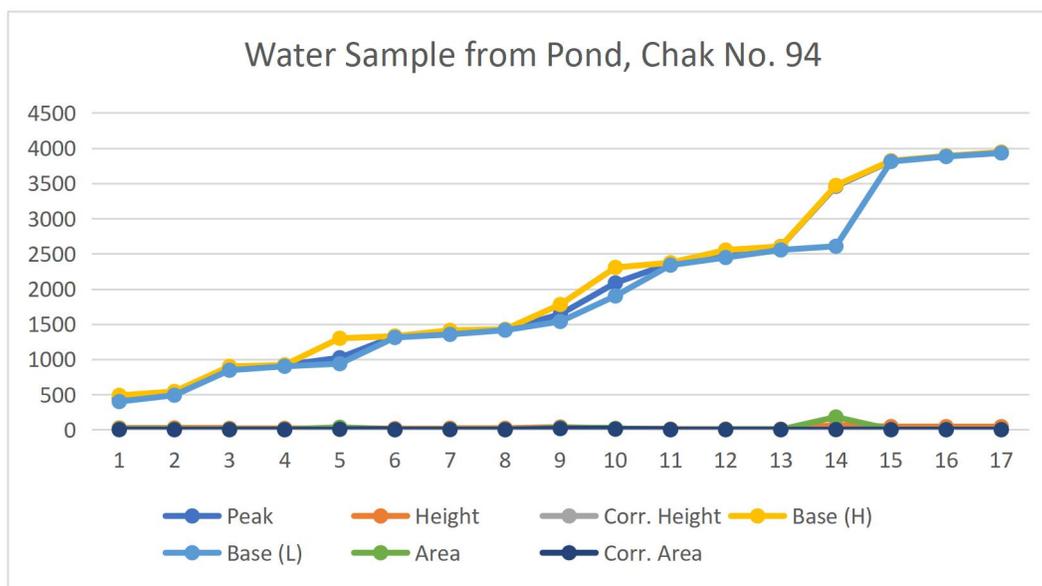
Figure 3: Line Graph of Water Sample from Pond, Chak No. 94

Figure 3 illustrates the evaluation of the water sample collected from Pond, Chak No. 94. The presence of multiple peaks suggests that the water contained various dissolved constituents. The principal peak suggests it is likely the main compound present in the water. The smaller peaks are also informative and likely represent trace contaminants or trace minerals.
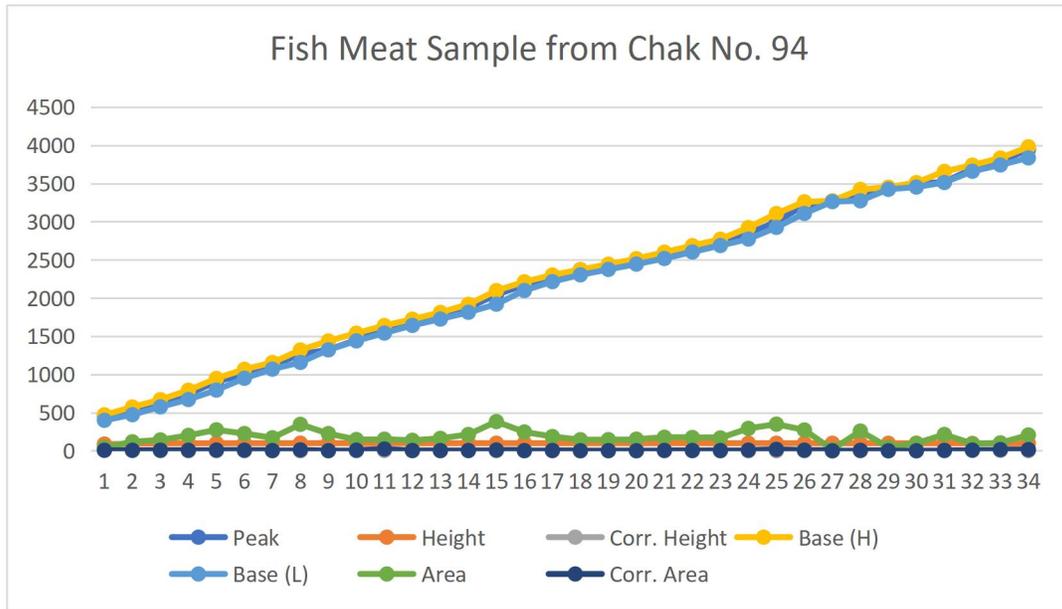
Figure 4: Line Graph of Fish Meat Sample from Chak No. 94

Figure 4 analyzes a fish meat sample from Chak No. 94, revealing multiple peaks that indicate varying concentrations of organic or inorganic compounds. The differences in peak heights and areas suggest potential contaminants, nutrients, or other substances. Further lab testing is needed to identify specific components and assess safety for consumption.
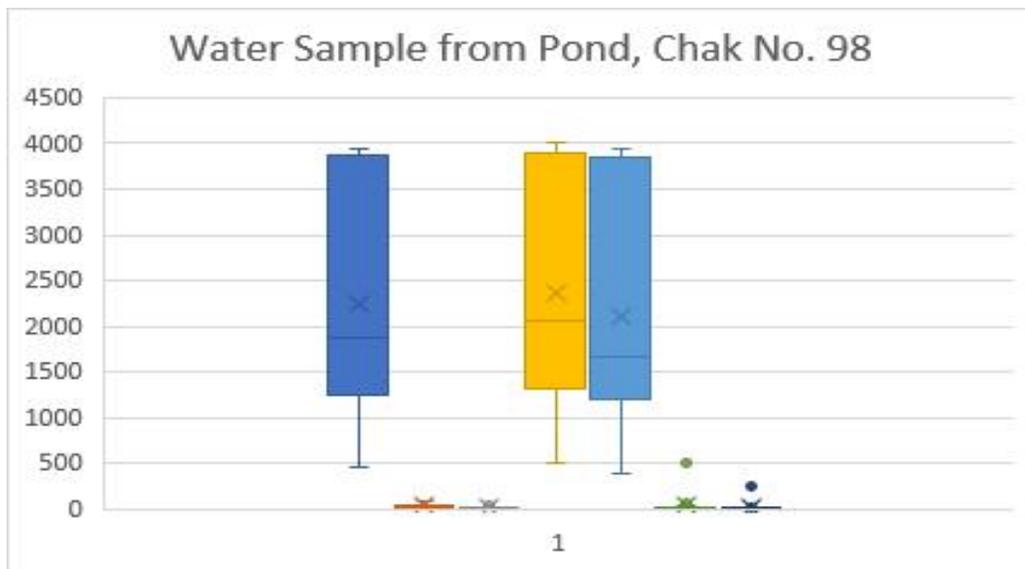
Figure 5: Box Plot of Water Sample from Pond, Chak No. 98

Figure 5 displays the box plot of Water Sample data from Chak No. 98, showing a wide range of values from -500 to 4500. The distribution appears skewed, with a longer tail towards the higher values, indicating potential outliers or variability in the sample. The median seems to lie around the middle of the range, suggesting a balanced central tendency.
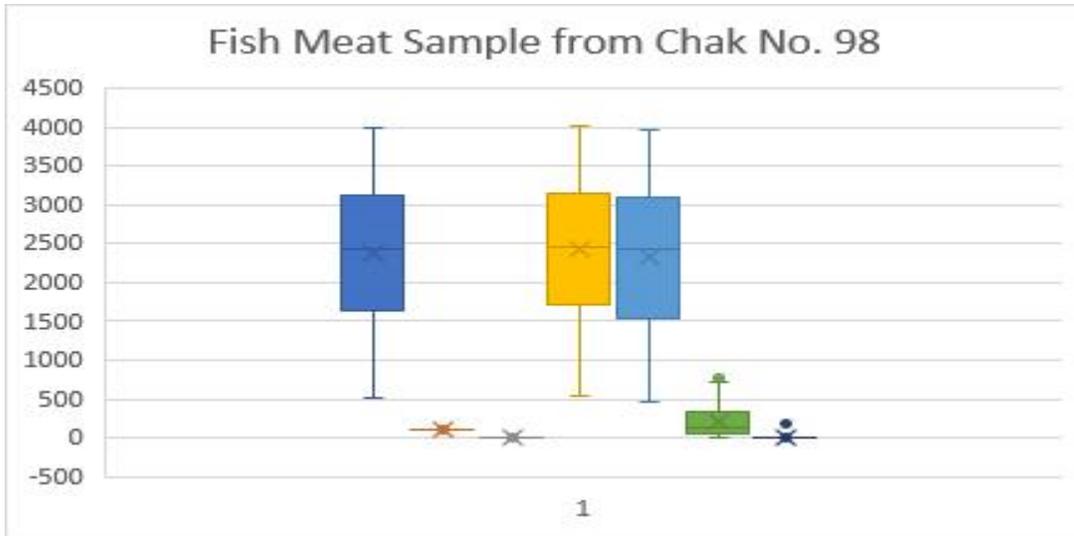
Figure 6: Box Plot of Fish Meat Sample from Chak No. 98

Figure 6 displays the box plot of fish meat sample data from Chak No. 98, showing a wide range of values from -500 to 4500. The distributio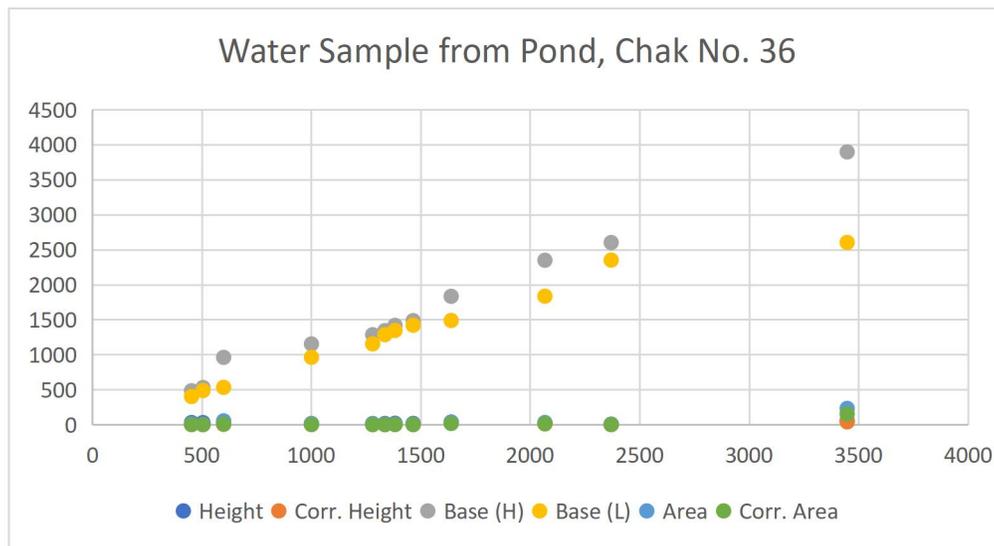n appears skewed, with a longer tail towards the higher values, indicating potential outliers or variability in the sample. The median seems to lie around the middle of the range, suggesting a balanced central tendency.

Figure 7: Scatter Plot of Water Sample from Pond, Chak No. 36

Figure 7 presents a scatter plot of water sample data from Pond, Chak No. 36, with values ranging from 0 to 4500. The plot shows a positive correlation between the measured variables, as indicated by the upward trend in data points. The labels suggest multiple parameters (e.g., Height, Area) were analyzed, highlighting potential relationships in the water quality metrics.
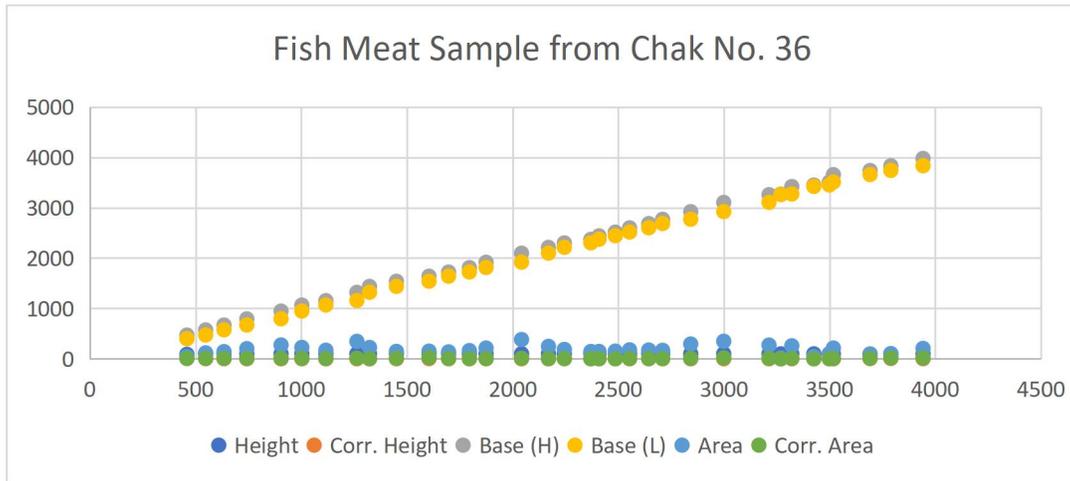
Figure 8: Scatter Plot of Fish Meat Sample from Chak No. 36

Figure 8 displays a scatter plot of fish meat sample data from Chak No. 36, comparing multiple parameters such as Height, Base, and Area. The plot suggests potential relationships or trends between these variables, which could indicate correlations in the physical or compositional properties of the fish meat. Further analysis would be needed to determine the strength and significance of these relationships.
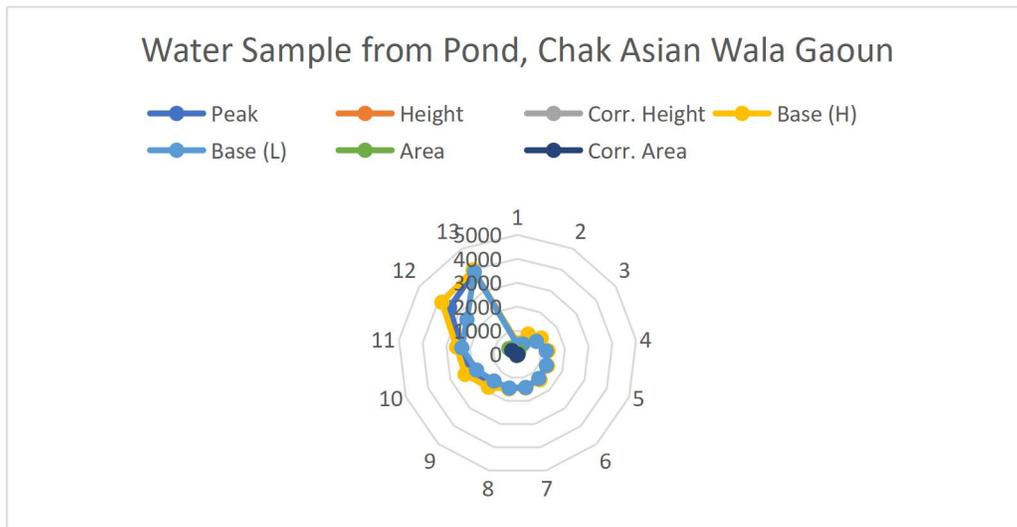
Figure 9: Radar Graph of Water Sample from Pond, Chak Asian Wala Gaoun

Figure 9, the radar chart shows the evaluation of water sample information from Pond, Chak Asian Wala Gaoun, showing Peak, Height, Area, and also the corrected values. The multi-axis plot shows the differences that exist among the measured properties, as some of the properties such Peak, and Corr. Height, show more extreme values than others.
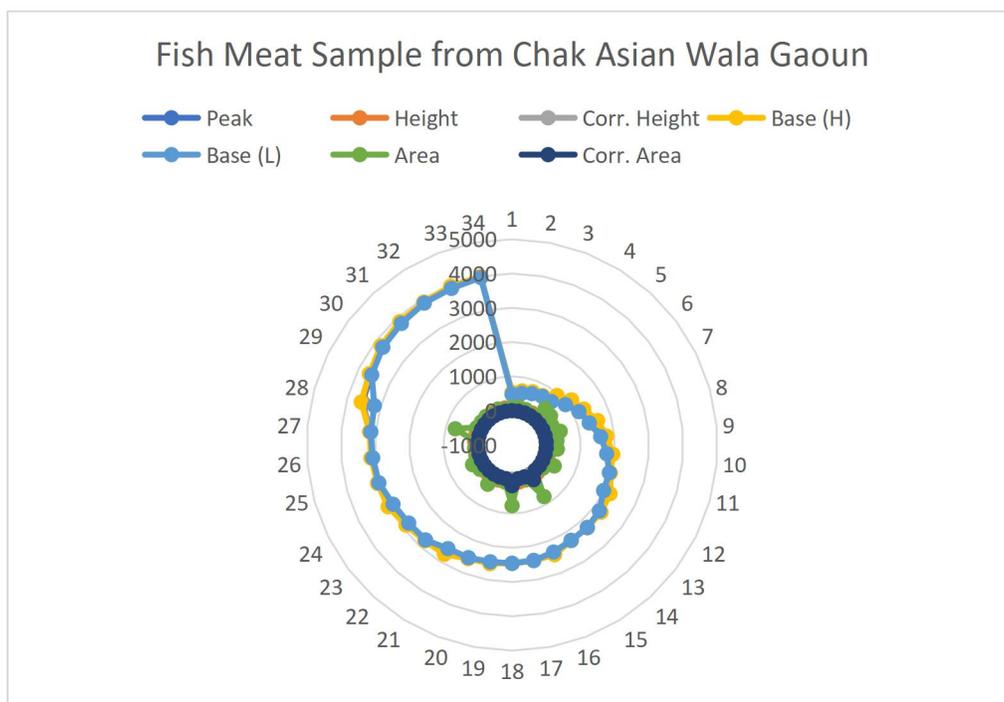
Figure 10: Radar Graph of Fish Meat Sample from Chak Asian Wala Gaoun

Figure 10 is a radar graph comparing fish meat sample parameters from Chak Asian Wala Gaoun including: Peak, Height, Area, and the corrected values thereof. The graph has the potential to be useful for comparing

DISCUSSION

Our study verifies the presence and abundance of microplastic contamination across five aquaculture ponds in Sargodha, Pakistan. We observed a range of synthetic polymers (including polyethylene (PE), polypropylene (PP), polystyrene (PS), polyethylene terephthalate (PET), and acrylonitrile-butadiene-styrene (ABS)) in both pond water and fish tissues *(Catla catla)* using Fourier Transform Infrared Spectroscopy (FTIR) analysis. Our findings are consistent with global observations that freshwater systems are becoming sinks for plastic debris, following the same pattern of urban and agricultural effluents to large rivers seen in India and China (Davranche et al., 2020).

measurement values, as it contains variation across measurement variables, with some parameters Peak, and Corr. Height observed higher values relative to other features.

Spatial variability was evident across sample sites. High FTIR absorption in Chak No. 39 and Chak Asian Wala Gaoun, especially in the 445–575 cm^{-1} and 1600–1800 cm^{-1} bands, suggested accumulation of degraded PE and oxidized plastic particles. Peaks associated with ABS (2090–2360 cm^{-1}) hinted at textile runoff and agrochemical contamination (Burns & Boxall, 2018). Such patterns underscore the role of localized human activities, particularly poor waste disposal and farming practices, in shaping contamination intensity (Ahamad et al., 2023; Bilal[a,b], 2021). Internal accumulation of microplastics in fish was confirmed. Specimens from Chak No. 36 and Chak No. 94 exhibited PET and nylon signatures in the 1000–1700 cm^{-1} and 2800–3900 cm^{-1} regions, similar to polluted freshwater systems in Europe. Conversely, fish from Chak No. 98 and Asian Wala Gaoun

showed fewer traces, suggesting variability in exposure or feeding habits.

Importantly, the presence of oxidized polymer markers (e.g., carbonyl stretches at 1700–1800 cm^{-1}) indicates potential leaching of toxicants like bisphenol-A and phthalates. Though histological analysis was not conducted, these findings suggest long-term health risks to aquatic life and consumers. Targeted local interventions, better waste control, and further toxicological studies are urgently recommended.

CONCLUSION

This study confirmed the presence of microplastic pollution in aquaculture ponds across Sargodha, Pakistan, through FTIR analysis of water and *Catla catla* fish tissues. Polymers such as polyethylene (PE), polypropylene (PP), polystyrene (PS), and PET were detected at all five sites, indicating contamination from agricultural runoff and poor waste management. The identification of microplastics in edible fish parts raises concerns about ecological disruption and human health risks through food chain transfer. This research highlights the need for continuous monitoring in South Asian freshwater systems and recommends further studies on microplastics' effects on aquatic organisms and sediment ecosystems.

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