# Microplastic Contamination in the Waters of Certain Rivers in Basrah City, Iraq: statistical study

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Received 24/03/2026 Accepted 01/07/2026 Published 28/07/2026

**Abstract**

Microplastics (MPs) are recognized worldwide as a growing environmental threat, especially in aquatic ecosystems. This raises concerns for human life and the environment due to the increased use and mishandling of plastics, particularly in urban waterways. This research presents statistics on the prevalence of microplastic particles in waters of five sites within the tributaries and the Shatt al-Arab River in Basrah, southern Iraq: the Qarmat Ali, Al-Khandaq, Al-Nadi Al-Athori, Shatt al-Arab, and Al-Bahadriya rivers. Chemical digestion using 30% $H_2O_2$ and density separation were used to remove unwanted substances. The water was then examined using optical microscopy and Fourier-transform infrared (FTIR) spectroscopy. The results indicated the existence of microplastics in all samples. The highest MP count was 15 particles/20 L at the Al-Khandaq and Al-Bahadriya River sites using a 125 µm sieve. The highest MPs count was 15.5 particles/20 L at the Al-Nadi-Al Athori River site using a 150 µm sieve. The highest MPs count was 15.5 particles/20 L at the Al-Nadi-Al Athori River site using a 150 µm sieve. The predominant form of microplastics across all study sites was fiber, accounting for 42% of the total. Similarly, the blue color 40% of microplastic was the predominant color across all water samples. FTIR measurements revealed that the predominant MP types were polypropylene 39.3%, low density polyethylene 35.5% and polystyrene 25.2%. MPs in these rivers are affected by human activity along their banks, such as industries, markets, and residential areas.

**Keywords:** Microplastics, polyethylene, polystyrene, low-density polyethylene, freshwater pollution, FTIR.

P-ISSN: 1812-237X, E-ISSN: 2788-5720, https://ijaqua.uobasrah.edu.iq/index.php/jaqua/index

## Introduction

Microplastics are a group of emerging pollutants that have attracted global and societal attention over the past decade owing to their presence in all environments (Ageel *et al*., 2022). Microplastics are found in seawater, oceans, freshwater, wastewater, food, air, and drinking water, whether bottled or tap (Myszograj, 2020). Microplastics are solid synthetic particles or polymers with regular or irregular shapes, ranging in size from 1 µm to 5 mm, and are insoluble in water (Frias and Nash, 2019). Microplastics are classified into primary microplastics, which are smaller than 5 mm at the point of production and secondary microplastics generated from larger particles (Saud *et al*., 2023). Microplastics are generated by the fragmentation of larger plastic materials owing to environmental factors such as high temperatures, UV radiation, stress, oxidation, and atmospheric pressure (Tiwari *et al*., 2020; John *et al*., 2022). Secondary microplastics may also originate from the breakdown of synthetic fibers during washing, commercial activities, and the use of single-use plastics. They also come from the electronics, automotive, textile, and paint industries, which are often dumped into waterways and rivers, leading to microplastic pollution (Kay *et al*., 2018; Wang *et al*., 2019; Chia *et al*., 2021). Owing to their small size and light weight, microplastics pose a persistent environmental threat. Their widespread presence has harmful effects on living organisms and humans (Sheriff *et al*., 2024). Because microplastics are persistent in the environment and not easily degraded, they cause significant damage to living organisms (Guo *et al*., 2020; Mu *et al*., 2022; Queiroz *et al*., 2020).

In addition, it acts as a carrier of heavy metals, fish pathogenic bacteria, and organic pollutants (Song *et al*., 2020). Microplastics can be ingested by zooplankton, fish, and waterfowl, causing their poisoning (Bai *et al*., 2021; Courtene *et al*., 2022). Microplastics can accumulate at higher trophic levels through the food chain and bioaccumulation (Miller *et al*., 2020). They are considered harmful to because of their stable properties and bioaccumulation. This is attributed to the addition of various substances during manufacturing process, such as dyes, pollutants, and flame retardants (Cai *et al*., 2023). Each individual usually consumes between 39,000 and 52,000 microplastics annually (Cox *et al*., 2019). Yan *et al*. (2022) also found higher concentrations of microplastics in the feces of patients with inflammatory bowel disease than in those of healthy individuals. Leslie *et al*. (2022) published research indicating the presence of microplastics in human blood and their ability to enter human organs. This research has attracted global attention, prompting numerous studies on microplastic contamination of water due to its serious impact on human. A study by Liu *et al*. (2022) in China aimed to identify the sources of microplastics and their primary components in surface and groundwater. Brown *et al*. (2023) studied microplastic pollution from a plastic recycling facility in the United Kingdom. Regarding local studies in Basra, Iraq, Hussein *et al*. (2022) investigated the pollution of the Shatt al-Arab River and indicated that the water suffers from microplastic pollution resulting from household waste and industrial activities. Al-Sarraj and Al-Ahmadi (2022) studied microplastic pollution in Mosul. Sultan *et al*. (2023) examined the characteristics of microplastics in tap water from 16 stations on the left bank of Mosul and confirmed microplastic contamination.

Despite the high rates of plastic production and consumption in southern Iraq, studies investigating the environmental distribution of plastics and identifying the types of plastics present in water are limited. Therefore, the current study aimed to evaluate the degree of river water contamination with microplastics in some rivers in Basra Governorate, with a particular focus on human activities in their vicinity, to assess the health risks to the populations dependent on these rivers.

## Materials And Methods

## Sample collection

The study approach was designed to cover a variety of human activities along the Basra rivers, including industrial and densely populated areas along the riverbanks. Water samples were collected monthly from November 2023 to April 2024 from five tributary locations in Basrah City, Iraq (Figure 1).

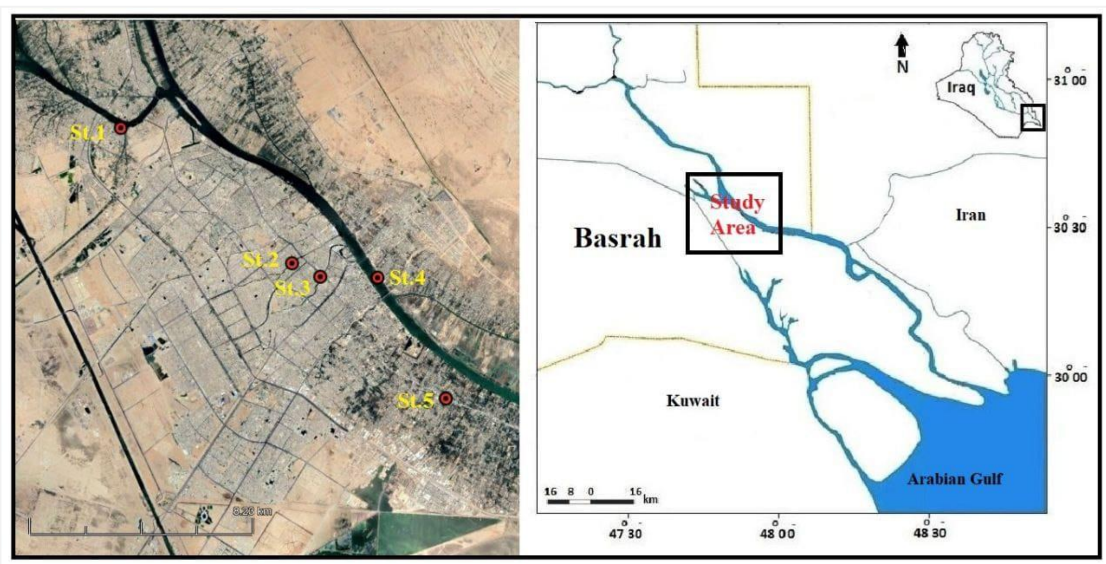


**Figure 1.** Sample Collection Map: It represents St.1 Shatt Al Arab, Qarmat Ali; St.2 Al-Nadi Al-Athori in the center of Basra city; St.3 Al-Khandaq River; St.4 Shatt Al-Arab River; and St.5 Al-Bahadriya River, Abu-Al-Khasib District, Iraq.

At each sampling site, 20 L of water was collected. The samples were subsequently passed through a series of stainless steel sieves with decreasing mesh sizes (63, 125, 150 µm), enabling the effective retention of microplastic particles on the sieve surface. The microplastics retained on each sieve were then collected directly in situ by thoroughly rinsing the sieves with distilled water, ensuring the complete recovery of the retained particles and minimizing sample loss. The collected materials were stored in clean glass bottles and transported to the laboratory for further analysis (Chen *et al*., 2023).

## Extraction of Microplastics

In the laboratory, samples containing collected MPs were dried in an oven at 90°C for 24 h. After drying, the materials were treated using the wet peroxide oxidation (WPO) method and density separation process. Subsequently, 20 mL of Fe(II) (0.05 M) solution, prepared by dissolving 7.5 g of $FeSO_4 \cdot 7H_2O$ in 500 mL of distilled water, was added to each sample. Following that, twenty mL of 30% ($H_2O_2$) was added. The mixture was heated on a hot plate at 75°C until gas bubbles appeared, indicating the oxidation and removal of organic matter from the samples.

After gradually cooling the mixture to room temperature, 20 mL of each sample was treated with six grams of sodium chloride for plastic separation by increasing the density of the solution. The samples were then transferred to a separation funnel and allowed to settle overnight (Masura *et al.*, 2015). The supernatant was collected and filtered using a 0.45 µm diameter filter paper. The filter paper was then placed in glass petri dishes and dried at 40-45°C for 24 hours (Parashar and Hait, 2022).

## Visual Analysis

Visual analysis was performed using a dissecting microscope with a camera (Optika, Italy). Samples were also examined using a light microscope with a camera (OPTO-EDU, China), and classified into the following main forms: fibers, films, fragments, foam, and pellets. They were further classified according to size and color. The quantity of MPs was determined by calculating the total number of MP particles per 20 L of water for all samples in this study (Alam *et al.*, 2023).

## Microplastics Diagnosis and Identification

The extracted MPs from the water samples were identified using FTIR spectroscopy (Bruker, USA). This device compares the MPs sample with the standard spectra of a known polymer in the FTIR spectral library (a high-resolution FTIR array) to detect the chemical groups of the MPs (Loder and Gerdts, 2015).

## Statistical analysis

A one-way analysis of variance (ANOVA) was conducted using SPSS Statistics (version 26.0). At a significance level ($P \leq 0.05$), only the Relative Least Significant Differences (RLSD) were found.

## Results and Discussion

In the current study, MPs were detected in all water samples collected from five tributary locations in Basrah and Shatt al-Arab. Statistical analysis showed that the number of MPs on a 63 µm sieve did not differ significantly among the collected sample sites ($P > 0.05$). The Qarmat Ali site had the highest average number of MPs, reaching 15.5 particles/20 L, as shown in (Figure 2).

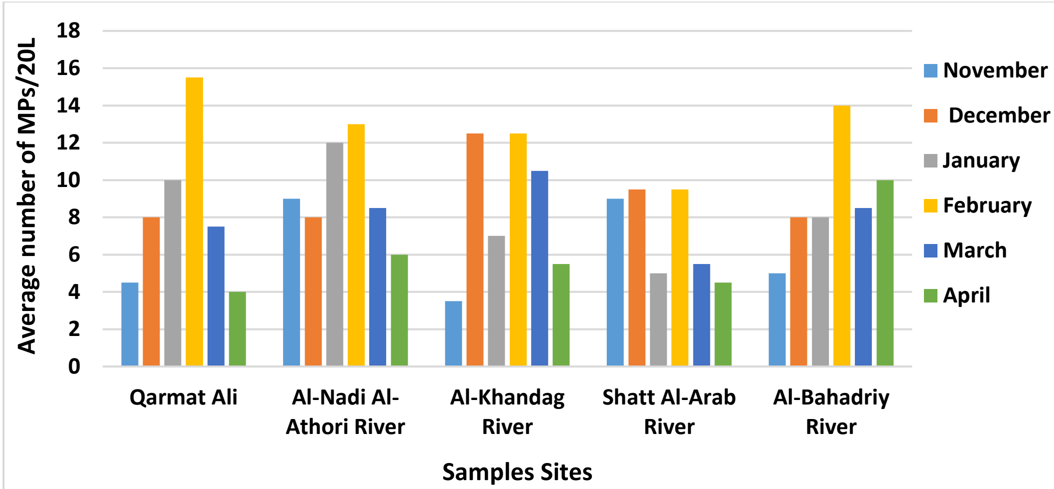


**Figure 2:** The mean count of MPs filtered through a 63µmin water samples.

The average MP count in the samples at the sieve with a 125 µm pore size showed no substantial variations among the sampling locations ($P > 0.05$). The Al-Khandag River site in January and the Al-Bahadriya River site in December had the highest number of MPs, averaging 15 particles/20 L, as shown in (Figure 3).

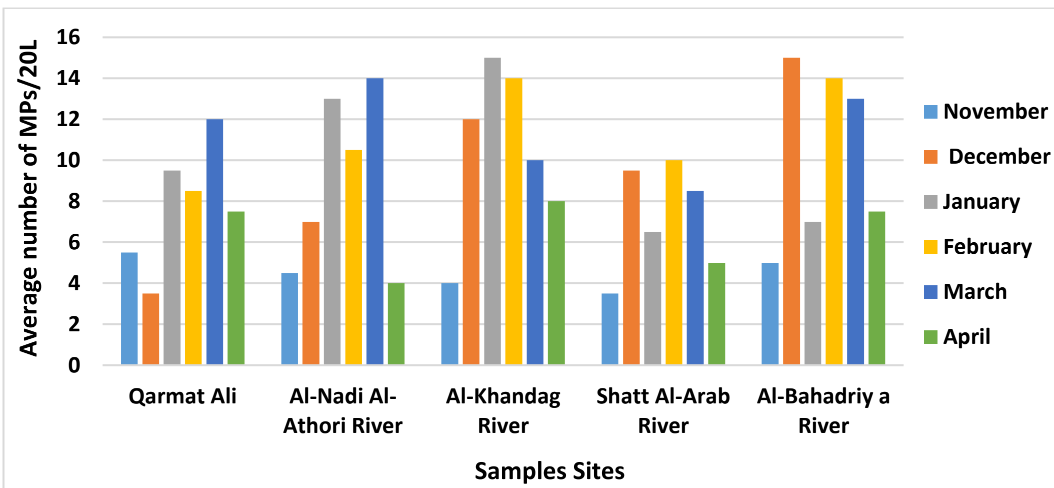


**Figure 3:** The mean count of MPs filtered through a 125µm sieve in water samples.

The statistical analysis of the rate of presence of MPs particles in the water samples collected with a sieve with 150 µm openings showed no significant differences between the sample collection sites ($P > 0.05$). The Al-Nadi Al-Athori River site contained the largest number of MPs at a rate of 15.5 particles/20 L in January, as shown in (Figure 4).

Surface water samples were collected from five sites located in the heart of urban regions, encircled by factories and business establishments. These elements may have led to the relatively high MP distribution. The elevated levels of MPs in the surface waters of Basrah are also linked to the various human activities and eateries situated along the banks of the city's inland rivers.

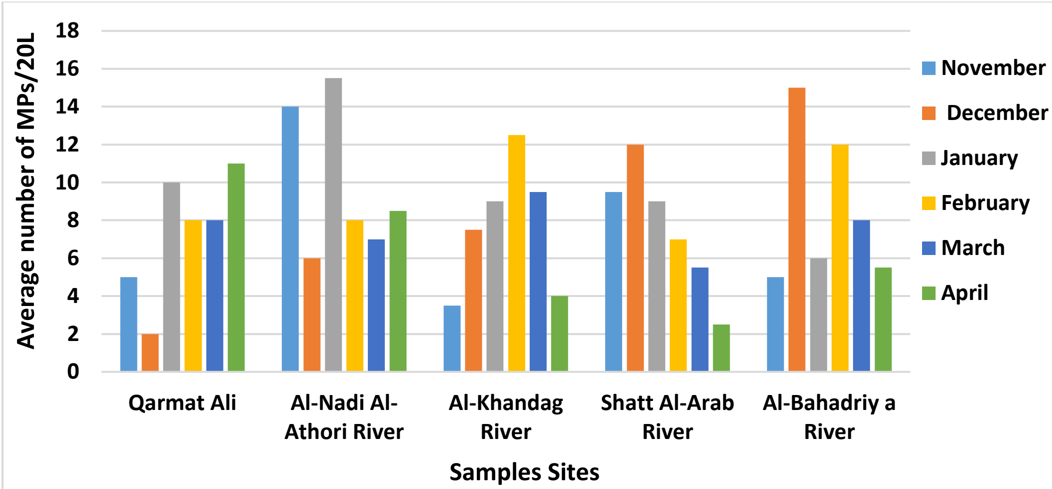


**Figure 4:** The mean count of MPs filtered through a 150 µm sieve in water samples.

The rise in MPs in recent years might be attributed to the expanding use of online shopping platforms, the surge in food delivery services, and the heightened consumption of plastic products. This leads to increased MPs pollution (Wang and Li, 2021). Plastic line fishing nets are prevalent in the Qarmat Ali area, and drainage water from the surrounding agricultural lands is discharged into the area. The Al-Nadi Al-Athori and Al-Khandag rivers are tributaries of the Basrah river system that receive large quantities of domestic wastewater and untreated sewage. Numerous residential and commercial complexes surrounding them have also contributed to MP pollution. Statistical analysis revealed significant differences between the months in which water samples were collected ($P < 0.05$), with the highest concentration observed in February at 11.267 particles/20 L. In Iraq, February is a rainy winter month, leading to higher levels of microplastic pollution, which is consistent with the findings of Liu *et al*. (2021). indicating higher levels during the rainy season.

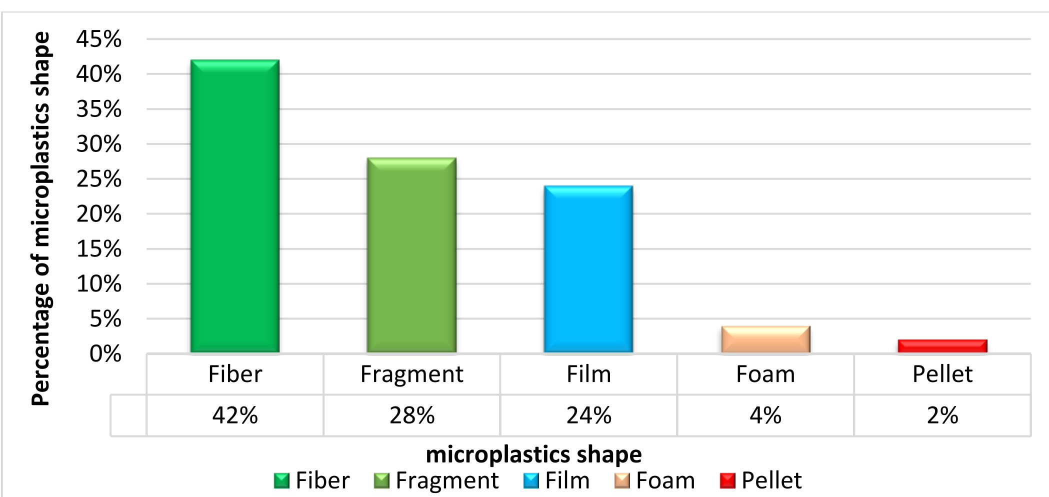


**Figure 5.** shows the percentages of MP shapes at each study site.

As shown by Elkhatib and Oyanedel-Craver (2020) and Na *et al*. (2021), rainfall in agricultural areas and cities is the primary source of MPs in water. The results of the current study, as illustrated in (Figure 5), indicate that the predominant form of MPs at all locations was fibers (42%). In comparison, pellets were the least common (2% of the total). Some microplastic particles were identified and characterized using optical microscopy. Representative images of these microplastics are shown in (Figure 6).

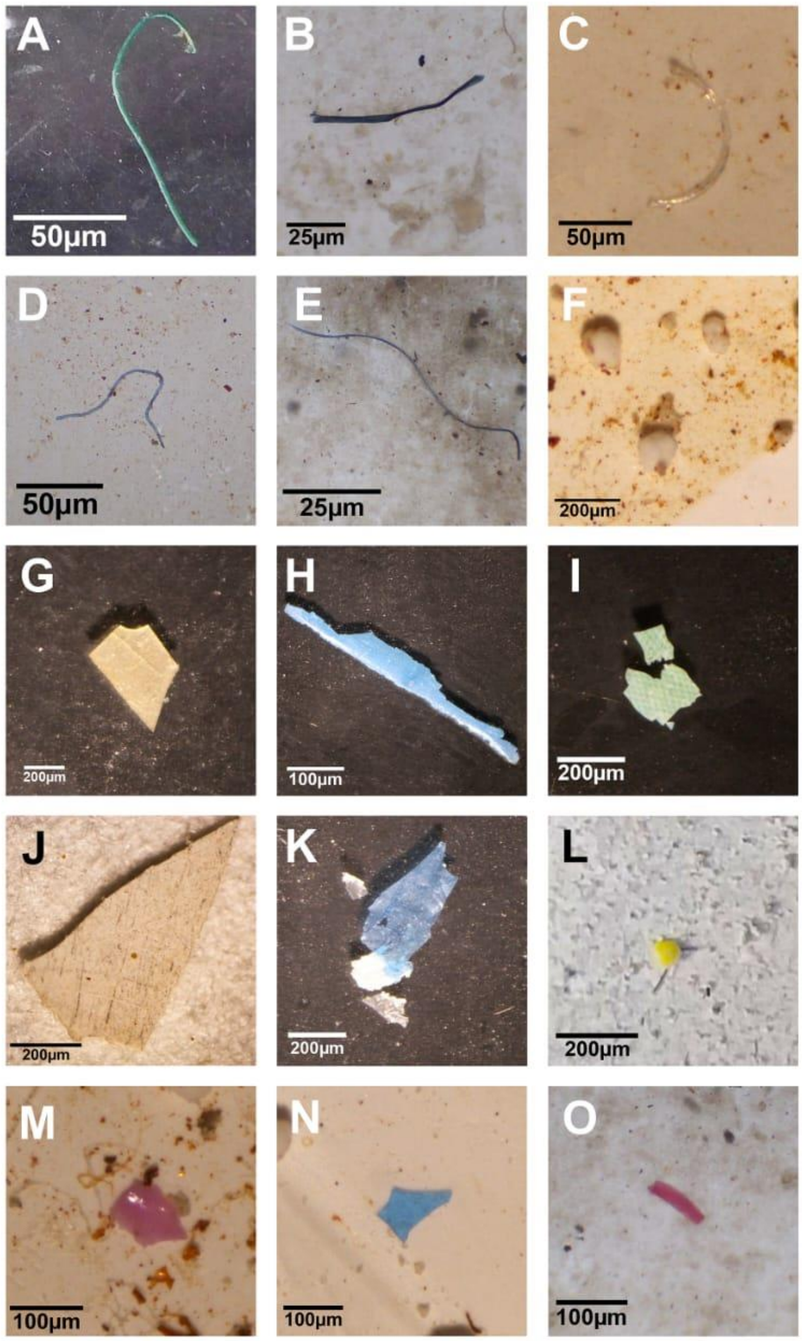


**Figure 6**. represents a set of MPs particles characterized by the optical microscope: fiber (A, B, C, D, and E), foam (F), fragment (G, H, I, and J), pellet (L), and film (K, M, N, and O ).

A study by Bouadil *et al*. (2024) on surface water in Morocco (Marrakech) also confirmed this result, with the most predominant types of MPs being fibers, fragments, pellets, and films. Because pellets have a high density and settle easily in water, there were not many of them in any of the samples used in this investigation (Zhang *et al*., 2017). Regarding the colors of the MPs that appeared in the results of this study, blue (40%) was the predominant color in all water samples collected from all study sites, followed by transparent (22%), black (15%), white (12%), green (6%), yellow (3%), and other colors (2%), as shown in (Figure 7).

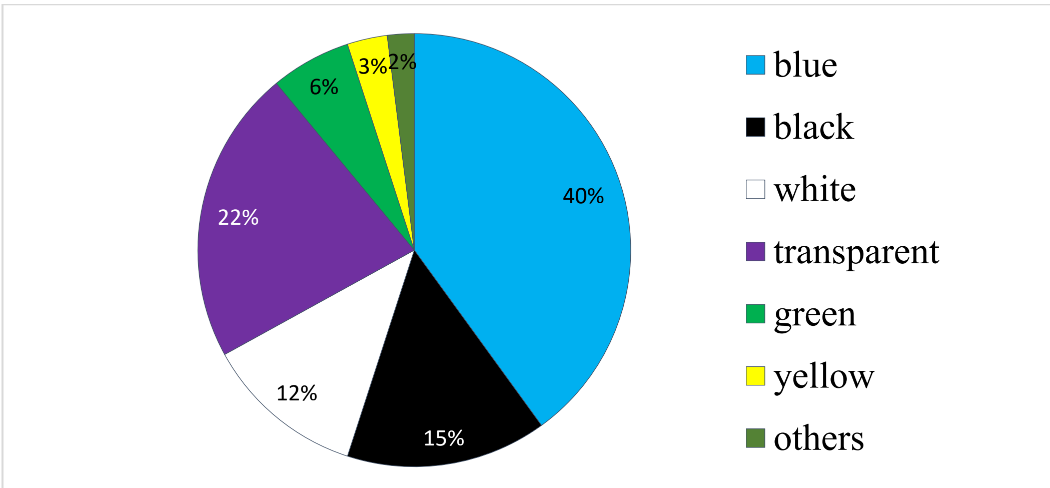


**Figure 7** Represents the colors of MPs that appeared in all water samples.

According to Fourier transform infrared (FTIR) spectroscopy data, the predominant type of microplastic was polypropylene (PP, 39.3%), followed by low-density polyethylene (LDPE, 35.5%), and then polystyrene (PS, 25.2%), as compared with the Central Library of Polymer Peak Spectra, as shown in (Figure 8).

These results are consistent with those of Mohammed *et al*. (2025), who studied the diversity of microplastic particles in the sediments of Khor Al Zubair city, located northwest of the Arabian Gulf in Iraq, and found that the most abundant MPs were of the PE and PP types. The widespread use of polyethylene (PE) and polypropylene (PP), the two main types of plastic, is due to their large-scale global production and their light weight, which facilitates buoyancy and movement with water currents (Wang *et al*., 2018). The presence of (PP), (PE), and (PS) in water samples is also attributed to the large quantities of plastic bottles used in packaging, shopping bags, electrical wiring, cosmetics, and window frames (Oni *et al*., 2020). The presence of MP types such as PP, PE, and PS is also attributed to the numerous human activities and restaurants along riverbanks. Therefore, there is an urgent need to adopt sustainable strategies for managing and recycling plastic waste in environmentally friendly ways in order to reduce the infiltration of microplastics into aquatic systems. The entry of microplastics into the environment causes health problems through ingestion by organisms or absorption by plants, and their transfer through the food chain ultimately reaches humans.

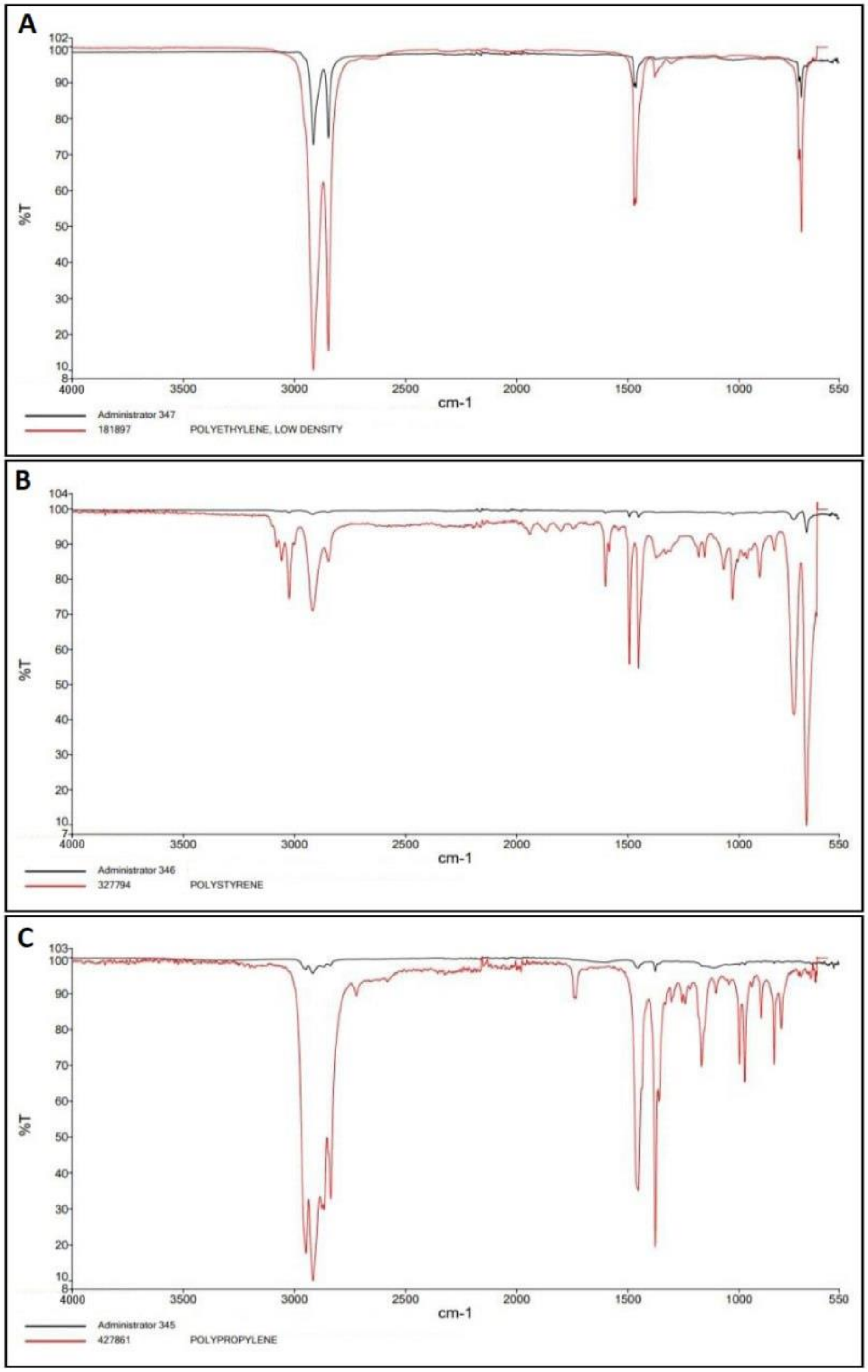


**Figure 8:** (FTIR) results showing the types of microplastics collected from samples: low-density polyethylene (A), polystyrene (B), and polypropylene (C).

In general, the results of this study, in agreement with a previous study by Al-Azzawi *et al.* (2024), showed that the abundance of MPs ranged from 27 to 74 particles/20 L of water collected from the Tigris River of Iraq. The fiber and fragments were the predominant forms in all water samples. PP, PE, and PS were the most common MPs, accounting for 66.92% of the samples. Also, the results are consistent with those of a study conducted in Nigeria on surface water, which reported a fiber content of 67% and that PP and PE were the predominant types of MPs in the water samples (Ololade *et al.*, 2024). In a study by Sadiq and Al-Hejuje (2025), which collected surface water samples from Shatt al-Arab in Basrah city, an average MPs count of 0.370 particles/L was found at the Mahila site using a 125 µm sieve. The same study also indicated that the highest concentration of MPs particles appeared in February, and the most common types are polystyrene and polyethylene terephthalate.

## Conclusion

This study confirms the widespread presence of microplastics in all water samples taken from river tributaries in Basrah city, Iraq. Polystyrene (PS), polypropylene (PP), and low-density polyethylene (LDPE) emerged as the most common types of microplastics. This highlights the critical state of freshwater ecosystems by measuring microplastic pollution in rivers. The increasing levels of microplastics, even in vital water sources, pose a direct threat not only to aquatic biodiversity but also to ecosystems, drinking water quality, and human health. This study underscores the need to adopt sustainable strategies for managing and recycling plastic waste in environmentally friendly ways and to integrate MPs monitoring into drinking water quality standards.

## Acknowledgements

The authors would like to express their gratitude to the University of Basrah/College of Science for providing the laboratory facilities for this research. We also extend our thanks to the Polymer Research Center at the University of Basrah for their assistance in conducting the FTIR analysis.

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# تلوث مياه بعض الأنهار في مدينة البصرة، العراق، بالجسيمات البلاستيكية الدقيقة: دراسة إحصائية

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تاريخ الإستلام: 2026/03/24 تاريخ القبول: 2026/07/01 تاريخ النشر : 2026/07/28

**المستخلص**

يُعد البلاستيك الدقيق تهديدًا بيئيًا متزايدًا على الصعيد العالمي، لا سيما في النظم البيئية المائية. ويثير ذلك مخاوف بشأن حياة الإنسان والبيئة بسبب الاستخدام المتزايد للبلاستيك وسوء التعامل معه، لا سيما في المجاري المائية الحضرية. تقدم هذه الدراسة إحصائيات حول انتشار جزيئات البلاستيك الدقيق في مياه خمسة مواقع ضمن روافد نهر شط العرب في البصرة، جنوب العراق: أنهار كرمة علي، والخندق، والنادي الأثوري، وشط العرب، والبهادرية. تم استخدام الهضم الكيميائي باستخدام 30٪ $H_2O_2$ لإزالة المواد غير المرغوب فيها. تم فحص المياه باستخدام المجهر الضوئي ومطيافية الأشعة تحت الحمراء. أظهرت النتائج وجود جزيئات بلاستيكية دقيقة في جميع العينات. وبلغ أعلى عدد للجزيئات البلاستيكية الدقيقة 15 جزيئة لكل 20 لترًا في موقعي نهري الخندق والبهادرية باستخدام منخل 125 ميكرومتر. وكان أعلى عدد للجسيمات البلاستيكية الدقيقة 15.5 جسيمًا لكل 20 لترًا في موقع نهر النادي الأثوري باستخدام منخل 150 ميكرومتر. وكان أعلى عدد للجسيمات البلاستيكية الدقيقة 15.5 جسيمًا لكل 20 لترًا في موقع نهر النادي الأثوري باستخدام منخل 150 ميكرومتر. وكان الشكل السائد للجسيمات البلاستيكية الدقيقة في جميع مواقع الدراسة هو الألياف، حيث شكلت 42% من الإجمالي. وبالمثل، كان اللون الأزرق هو اللون السائد في جميع عينات المياه، حيث شكل 40% من الجسيمات البلاستيكية الدقيقة. أظهرت قياسات FTIR أن أنواع الجسيمات البلاستيكية الدقيقة السائدة هي البولي بروبيلين بنسبة 39.3٪، والبولي إيثيلين منخفض الكثافة بنسبة 35.5٪، والبوليسترين بنسبة 25.2٪. وتتأثر الجسيمات البلاستيكية الدقيقة في هذه الأنهار بالأنشطة البشرية على ضفافها، مثل الصناعات والأسواق والمناطق السكنية.

**الكلمات المفتاحية:** الجسيمات البلاستيكية الدقيقة، البولي إيثيلين، البوليسترين، البولي إيثيلين منخفض الكثافة، تلوث المياه العذبة، FTIR.