The Characterization Of The Microplastic Contamination In The Najafgarh Drain Of Yamuna, Delhi

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ABSTRACT

Microplastics are small sized plastic particles that are produced in cleaning, cosmetic, pharmaceutical industries etc as well as result from the larger plastic products by means of transportation damage, friction, sunlight action etc. due to its miniscule size it is very harmful to aquatic as well as terrestrial organisms as they ingest it and it leads to damage of organs and their functioning. Microplastics are decade-old pollutants that have been traced across every environmental component and it has contributed to the overall build-up of plastic pollution. Microplastic pollutants have detrimental impacts on both aquatic life and human health. Since it is a very recently discovered pollutant hence it is the hot topic for the scientists and researchers in field of sciences and life sciences. This thesis investigates the presence, distribution, and characteristics of microplastics in the Najafgarh Drain, a critical waterway in Delhi, India This project covers qualitative analysis of microplastics using Fourier transform infrared spectroscopy (FTIR) and Scanning electron microscope (SEM) in the samples collected from locations nearby Najafgarh drain water. Using FTIR we saw the presence of PP, PVC, PE, PET etc. and compared it with the data of already present analysis. The presence of PET, PVC and NY were more compared to PP and PE. This might be because of presence of common household trash and wastes from nearby localities and religious places around the sampling sites where chadars, chunni, and other materials are being discarded into the drain.

Keywords: Microplastics, Waste, Najafgarh.

INTRODUCTION

Plastic is a widely used synthetic polymer which has become a very common and useful product in today's world, it's been widely used as a packaging material, and it finds its place in many industries majorly including pharmaceuticals, toys, food packaging etc. The increasing population has also led to increase in the demands of plastics products because of its cheap price, versatile uses, long durability and unreactive nature. The amount of plastic production has increased manifolds in the previous decades. In 1950, the world produced just two million tonnes. It now produces over 450 million tonnes. India also being the country of spiritual values, high religious sentiments also lead to the dumping and erosion of microplastics as mentioned in the reports of (Amrutha and Warrier 2020, Ahmad et al 2005) , the sampling sites near to important pilgrim centres like Dharmasthala and Subrahmanya, register higher concentration of fibres released due to washing of clothes. The study concludes that the Netravathi River is contaminated with microplastics from its origin to the sink. Microplastics are decade-old pollutants that have been traced across every environmental component and it has contributed to the overall build-up of plastic pollution. Microplastic pollutants have detrimental impacts on both aquatic life and human health. The fate of microplastic is based on its circulation and deposition in the environment. Microplastic pollution and climate change have a major role in deciding the fate of microplastics.

According to Plastic Europe (2023) world plastic production will be recorded as 400.3 Mt (million metric tonnes) in 2022 with an increase of 1.6 percent from the previous year. Due to its characteristics like longevity, elasticity, and persistent under harsh environments, the demand for plastic has been consistent in the market, a report from Plastic Market Size Worldwide 2033 shows the increase of the market price of 712 billion US dollars in 2023 which is being forecasted to reach 1,050 billion to come in the next decade. Its high tensility, small size, slow degradation nature, and high adsorbent characteristics make it a major environmental threat (Ajith et al. 2020, Cole et al. 2013). Microplastics are small particulates of plastics which ranges in size from 5mm which were first recognised by. They found plastic archived among the plankton in samples back to the 1960s, but with a significant increase in abundance over time. They also found similar types of polymers in the water column as in sediments, suggesting that polymer density was not a major factor influencing distribution (Thompson et al. 2004, Ahmed et al 2016).

The Yamuna River was one of the most important freshwater resources for the Delhi, located in Northern India however today its highly polluted with all kinds of pollutants including, plastics, heavy metals, toxic chemicals etc. Through its course in the city, the Yamuna river receives partially treated and untreated wastewater discharges from around 16 drains (Mazhar et al 2023, Kesari et al. 2021) and has been found contaminated with harmful pollutants like heavy metals, antibiotics, and pathogenic microorganisms. The Najafgarh and Shahdara are of primary importance as they discharge the maximum load of wastewater into the river. The river water quality is also affected by inefficient solid waste management practices in the city. The current trend of plastic waste generation in Delhi reaches nearly 2.3105 tons annually which presents a substantial risk of MP contamination in different environmental areas of this city, especially the Yamuna River. Today Yamuna River is a threatened resource of freshwater in Delhi, India. MPs showed an increase in abundance in the river from the Wazirabad barrage (n ¼ 500 MPs/m3) to the Okhla barrage downstream (n ¼ 3,900 MPs/m3) in Delhi with a maximum abundance downstream to the Najafgarh and Shahdara drain outfalls. White color and fragmented shape were prevalent characteristics of the isolated MPs. Attenuated total reflectance–Fourier transform infrared (ATR-FTIR) spectroscopy revealed five types of polymers. Heavy metals (chromium, lead, manganese, and iron) and fecal coliforms were at unacceptable levels at most of the sampling sites. Due to the emergence of issues concerning the tendency of MPs to actively interact with heavy metals and pathogenic microorganisms, investigation of the co-occurrence of such harmful pollutants is very important. (Madhav et al. 2023, Vaid et al. 2022) .

(Menéndez-Pedriza and Jaumot 2020) divided into large (1–5 mm) and small (1–1000 µm). Larger plastics were categorized as mega plastics (larger than 1000 mm), macroplastics (from 250 to 1000 mm) and meso plastics (from 5 to 250 mm). Below the 1 µm scale, plastics should be designated as nano plastics (NPs), another rather unknown part of the marine waste. MPs come from two main sources, e.g., primary, and secondary. Cosmetics, paints, biomedical equipment, drugs, etc. fall in the primary category of MP sources whereas mechanical/thermal/biological degradation of macroplastics falls makes up the secondary sources of MPs (Gangadoo et al. 2020). Due to their distinctive properties like large surface area, small size, and inert nature, MPs can effectively interact with other contaminants in their vicinity through sorption mechanisms (Menéndez-Pedriza and Jaumot 2020). Studies have shown interactions of MPs with heavy metals, organic pollutants like organophosphorus flame retardants, pesticides, antibiotics, and pathogenic microorganisms Such interactions of MPs with other chemical or biological species may enhance their toxic potential and generate a range of health impacts if ingested by living organisms (Khan et al 2022, Naqash et al. 2020)

Thompson et al, 2004 recorded presence of plastic archived among the plankton in samples back to the 1960s, but with a significant increase in abundance over time and called it microplastic due to its small size. They also found similar types of polymer in the water column as in sediments, suggesting that polymer density was not a major factor influencing distribution. These are produced for various cosmetic, pharmacy, and household products, etc, they are also produced by the splintering larger plastics under high temperatures, friction, microbial activity, etc. (Prata et al. 2019)

The small size makes it easy to reach down into the soil, and groundwater (Colmenarejo Calero, Kovač Viršek, and Mali 2024) eventually reaches aquatic and terrestrial organisms and humans through the food chain. However the amount of microplastic is significant in water but only 20% constitutes oceanic sources which are mostly from fishing nets, the remaining 80 percent comes from terrestrial surfaces including beach litter (Andrady 2011) via wind, air, wastewater, leachate, etc.(Sekar and Sundaram 2023) (Qiu et al. 2020). Initially, microplastics due to their small size are ingested by smaller micro-organisms like zooplankton and phytoplanktons (Lehtiniemi et al. 2018) and gradually reach higher trophic levels through the food chain (Cverenkárová et al. 2021).

These micropollutants have been traced and reported in the marine environment (Andrady 2011), freshwater (Eerkes-Medrano, Thompson, and Aldridge 2015) terrestrial environment (Mai et al. 2018), wetlands(Paduani 2020; Kumar, Sharma, and Bandyopadhyay 2021), dust on road from tyre screech (Kole et al. 2017), air (Dris et al. 2017) and human blood (Leslie et al. 2022). Surprisingly microplastics are also present in indoor dusts (Liu et al. 2019) and most common type of MP were reported to be PET (J. Zhang, Wang, and Kannan 2020).

In a research done by (Amrutha and Warrier 2020) in the Nevrathi river which joins the Arabian Sea the samples showed the presence of microplastics with a mean numerical abundance of 288 pieces/m3 (water), 96 pieces/kg (sediment) and 84.45 pieces/kg (soil) as mentioned in table 1 their investigation reports, mentioned that the sampling sites near important pilgrim centers like Dharmasthala and Subrahmanya registered higher concentrations of fibers released due to washing of clothes. The study concludes that the Netravathi River is contaminated with microplastics from its origin to the sink. Fibres, films and fragments are the main categories obtained from the catchment. The microplastics present in the samples were mostly transparent and white coloured which are due to the decay of plastic carry bags, packing materials and fishing lines.

In a study, ("Microplastics in Wastewater: Microfiber Emissions from Common Household Laundry | Environmental Science and Pollution Research," n.d.) by galvao et al 2020 shows that while washing daily wear clothes in a standard used washing machine, microfibres were found out of which 40% of the synthetic fibers released were in the range 100–500 µm and 53% in the range 50–100 µm, with only 7% of synthetic fibers were found longer than 500 µm. ((Shen et al. 2021) reported that uring the COVID-19 pandemic, the increase in the use of single-use plastic surged as there was a scarcity of surgical masks, common people would wash them to reuse, this released microplastics, and with multiple number of washes, the amount of microplastic release kept increasing. In the experiment, the masks were washed and disinfected using water, detergent, and alcohol, and with every further use the amount of microplastic was recorded, it was also noticed that with the number of microplastics being released, the size of microplastic kept decreasing, about 50% of the microplastics released was of less than 0.5mm in size and 80% was less than 1mm.

In another study done by (Bergmmann et al, 2019 "White and Wonderful? Microplastics Prevail in Snow from the Alps to the Arctic," n.d.) MPs were identified by Fourier transform infrared imaging in 20 of 21 samples. The MP concentration of Arctic snow was significantly lower (0 to 14.4 × 103 N liter−1) than European snow (0.19 × 103 to 154 × 103 N liter−1) but still substantial as mentioned in table 1 Polymer composition varied strongly, but varnish, rubber, polyethylene, and polyamide dominated overall. Most particles were in the smallest size range indicating large numbers of particles below the detection limit of 11 micrometre.

The pervasiveness of microplastics can be seen in lakes, rivers, oceans, sea, and even in the cold Mt Everest (Napper et al. 2021a)) and other cryospheric regions (e.g., Arctic, Antarctic, Alps, Andes, etc.) (Y. Zhang et al. 2022). Studies show the presence of microplastics in rainwater, sea fog (Sang et al. 2021, Abbasi 2021), hail (M et al. 2023), etc. It is also called man-made dust as the large plastic debris from oceanic shores, nearby coastlines, and freshwater bodies gets photodegraded under sunlight, physical abrasion, hydrolysis, and biodegradation by some algae and microbes like bacteria (Yuan et al, 2020) and is transported by high altitude winds into the ocean and sea.(Kozjek et al, 2023). Another major source of microplastics is found along the road including road dust, flyers, banners, wrappers, etc, which upon degrading under sunlight, high altitude winds, and through rainwater run off into the groundwater and sewer and eventually reach the river and marine water. (Kole 2017). Studies were done in the cities of India, Chennai (Narmadha et al 2020), Nagpur (Patchayiappan et al 2021), and Varanasi (Pandey et al 2022), show that road dust and stormwater (Monira et al 2022 Saurakhia et al. 2017) the major cause of airborne microplastics in both urban and rural environments which includes both suspended and settled dust.

With further development and scientific research, new methods have been introduced into the field of agriculture including plastic mulching, it is done to regulate moisture, and temperature, and prevent unwanted organisms and weeds in the crop field (Huang et al. 2021). People choose rural areas for recreational purposes and the amount of litter dropped by them is becoming one of the major sources of plastic pollution, components from the trekking shoe sole abrasion are reported to inhibit photosynthesis in plants (Lee et al, 2022). Shoe sole abrasion is one inexorable source of microplastic the study shows its effect on the plant *Vigna radiata* and is known to toxicate the soil environment.

Microplastics reach rivers, lakes, ponds etc ecosystems via many routes. Many sewage treatment plants discharge their wastewater into the river which carries a good amount of microplastic. (Bordós et al, 2019). Microplastics contribute significantly to plastic pollution in marine environments, accounting for 75% to 90% of the total from land-based source (Duis and Coors 2016). It has been forecasted that there will be a significant increase in land-based plastics by 2025, with sewage and stormwater as a major contributor (Derraik 2002; Jambeck et al. 2015). Microplastic residues from both domestic and industrial sources are either dispersed by natural disasters like hurricanes and flooding or transported to the marine environment through sewage systems (Čulin and Bielić 2016; Ziani et al. 2023). The thawing of glaciers releases frozen microplastics into the environment, adding to ocean microplastic pollution (Haque and Fan 2023). As glaciers melt, these particles enter waterways, most likely as a result of atmospheric deposition or human activity. Rising global temperatures and melting glaciers exacerbate microplastic pollution, highlighting the interconnectedness of terrestrial and aquatic ecosystems, as well as the role of climate change. Microplastics can also be found in medicines used to deliver drugs to humans and animals which are discharged into waterbodies through sewage systems (Kockisch et al. 2003; Wen, Kim, and Leong 2003). Since up to 29% of synthetic fibres in the marine environment are microplastics, atmospheric fallout may be a factor in the pollution of these fibres (Dris et al. 2017). The remaining 10%- 25% of marine plastic pollution comes from ocean-based sources (Ramirez-Llodra et al. 2013). According to one study, the primary source of these materials is paint and fibrereinforced plastic matrices used in ship coatings In Ocean masses, the concentration of microplastics has been reported, including the Atlantic, Pacific, Arctic, Southern, and Indian oceans. The concentrations range from 0.01 to 501 particles/m3 in the Atlantic Ocean (Enders et al. 2015; Ivar do Sul et al. 2013) , 0.004 to over 16,000 particles/m3 in the Pacific Ocean (Song et al. 2014; Doyle et al. 2011), and 0.031 to 0.34 particle/ m3 in the Southern Ocean (Lusher et al. 2015; Isobe et al. 2017) . The Indian Ocean has concentrations ranging from 0.39 to 3.70 particles/m3 (Isobe et al., 2014, 2015).

The source of microplastics in the water ecosystem is vast; they are broadly characterized into two main categories, primary and secondary. The primary sources of microplastics in terrestrial ecosystems are distinguished by their small size and persistent presence, factors that have a significant impact on soil organisms and may culminate in the phenomenon of bioaccumulation (McMullen et al. 2024). The atmospheric sources have a ubiquitous presence of microplastics (Y. Zhang et al. 2022). whereas, in the aquatic environment, it has widespread contamination which has an impact on marine life. The major contributor to marine plastic pollution is land-based plastic litter from densely populated cities and industrialized areas, fishing fleets, and marine recreational activities (Derraik 2002; Jambeck et al. 2015). Improper waste disposal in rivers and municipal drainage systems further pollutes the marine environment. In both the environment organisms suffer from reduced food uptake and energy reserves(Duis and Coors 2016)

The fate of microplastics depends upon the particle size and density, larger sizes readily get settled due to gravity (Vertical transport) while the smaller ones get circulated (Horizontal transport) in different ecosystems via different biogeochemical cycles and processes (Haque and Fan 2023)Other factors like water turbulence, surface tension and buoyancy (Valero et al. 2022) aggregation and agglomeration (Y. Li et al., 2019), chemical interaction (Yang et al., 2021), Hydrodynamic conditions (Kumar, Sharma, and Bandyopadhyay 2021) , sediments properties(Y. Li et al., 2019) and biofilm formation have an impact on suspension of microplastics (Sooriyakumar et al. 2022).

Climate change has a significant role in the trajectory of microplastics, manifesting in various pathways that decide the fate of microplastics within the ecosystem. The release of microplastics into the sea from the melting ice of glacial, compounded by intensified rainfall facilitating the transportation of plastic debris from shorelines, underscores the intricate interplay between climatic factors and microplastic distribution, Moreover, the redistribution of microplastics by stronger wind, and the buildup of microplastics in the soil during droughts have accentuated the multifaceted impact of climate change on microplastic dynamics within the ecosystem(Haque and Fan 2023, Ahmed and Panwar 2016).

Table 1 shows various types of microplastics found in different ecosystems

S.No	Location	Sample Type	Size/range	MP type	Reference
1.	Netravathi River, India	Water	1-5mm (34.6%) 1-0.3mm(65.4%)	Fibres (51.59 %) films (34.92 %)	(Amrutha and Warrier 2020)
		sediment and soil	1-5 mm(52.79 %) 0.3-1mm(47.21 %)	fibres (57.14 %) fragments (34.29%) films (5.71 %)	(Amrutha and Warrier 2020)
2.	Ganges, India	surface water	0.038 MP/L	Microfibres (91%) Fragments(9%)	(Napper et al. 2021)
3.	Arctic region	Snow	0.02 × 10-3 to 154 × 10-3 MP/L	Microfibres	(Bergmann et al. 2022)
4.	Silver Beach, India		1-5 mm (100%) 204 items/kg	polyvinyl chloride, polyethylene, and nylon	(Perumal and Muthuramalingam 2021)
5.	Wei River Basin, Yellow River, China	surface waters	3.67 to 10.7 items /L	Fiber (50.1%) (polyethylene., Polyvinyl chloride and polystyrene)	(Ding et al. 2019)
6.	Najafgarh rain, India	Surface water	2.9 × 10^3 MPs/m^3		(Vaid et al. 2022)
7.	Shahdara drain, India	Surface water	5.2 × 10^3 MPs/m^3		(Vaid et al. 2022)
8.	Yamuna, India	Surface water	1.78*10-3 MPs/m3	Fragments (60.7%), pellets (19.6%), Fibers (16.8%)	(Vaid et al. 2022)
9.	Chi River Thailand	Surface water	336 MP/L	Fibres(40)Fragments(54) Sphericals (6)	(Wibuloutai et al. 2023)

Impact of microplastics on humans and plants

Although nature has made human skin as a barrier to prevent entrance of foreign materials, germs, bacteria to enter pollutants also find some loopholes. Studies show that even though size of microplastic is large enough to not enter through skin but wounds, sweat glands, large skin pores and hair follicles may allow them to enter (Yee et al. 2021). Another common way of entrance of microplastics into human body is via inhalation and ingestion (Prata et al. 2020).

(Azeem et al. 2021) in his studies mentions about new modern techniques of farming like plastic mulching, tilling and irrigation allows , microplastics to reach deeper layer of soil and makes it an impossible process to remove it. Microplastics show effect on phytochemicals , photosynthesis process and also decrease in biomass of fresh leaf and roots tissues have been reported. The size, type and oxygen group also have diverse effects on the physiology of plants for eg the presence of PC type of MP on tomato plant inhibited plant germination, root and seedling length (Ge et al. 2021). A 7 day exposure of , PS-MP on rice plant showed shortening of shoot length with decrease in the biomass of the rice leaves, it also affected the TCA cycle of the plant along with other important metabolic cycles for eg, glycolysis and amino acids (X. Wu et al. 2020).

In another experiment done by (Y. Wu et al. 2019) on freshwater algae, the MP exposure on day 7 showed great decline in production of chlorophyll a content, hence inhnbiting the photosynthesis process in *chlorella*, *microcystic* and *pyreniodosa,* it also showed that PVC has more inhibiting efficacy than PP type microplastic. (Liao et al. 2019) studied about exposure of PS type microplastic on wheat plants and initially the photosynthetic content and soluble protein content increased with increase in MP exposure however with gradual increase the process took a turn and a decrease in chlorophyll content along with soluble protein content was noticed, it also caused the inhibition of root and stem elongation, along with decrease in metabolism functions and oxidative stress.

Above mentioned cases were of direct exposure of microplastics to the plants however microplastics also affect various plant on secondary level eg, presence of microplastics have been reported in honey, wax (Alma, de Groot, and Buteler 2023) , milk and beer (Diaz-Basantes, Conesa, and Fullana 2020).

Table 2 shows effect of MPs on Plants.

S. No	Plants	Effect on plants	MP Types	Reference
1.	Oryza sativa (rice)	Decrease in shoot length Decrease in leaf biomass Decline in TCA cycle	PS-MP	(X. Wu et al. 2020)
2.	Tomato	Decrease in root length Inhibition of plant germination Decline in growth of seedlings	PC-MP	(Ge et al. 2021)
3.	Freshwater Algae	Inhibition in content of chlorophyll-A	PVC and PP	(Y. Wu et al. 2019)
4.	Wheat	Inhibition in root and stem elongation Increase in oxidative stress	PS-MP	(Liao et al. 2019)

TYPES OF MICROPLASTICS

There are two types of microplastics, primary and secondary (Fig 1). Primary microplastics are manufactured for various domestic and industrial purposes. Primary microplastics enter the environment directly through any of various channels—for example, product use (e.g., personal care products being washed into wastewater systems from households), unintentional loss from spills during manufacturing or transport, or abrasion during washing (e.g., laundering of clothing made with synthetic textiles).Examples of primary microplastics include microbeads found in personal care products, plastic pellets (or nurdles) used in industrial manufacturing, and plastic fibres used in synthetic textiles (e.g nylon).Secondary microplastics form from the breakdown of larger plastics; this typically happens when larger plastics undergo weathering, through exposure to, for example, wave action, wind abrasion, and ultraviolet radiation from sunlight. Microplastics are not only of different sizes but are also of different shapes like microbeads, fibers, fragments, film foam pellets, and filaments to mention some (Hidalgo-Ruz et al. 2012); (Wright, Thompson, and Galloway 2013)

Microplastics can be broadly studied under two major sources, primary and secondary. When plastics are originally produced in sizes less than 5mm, they are included under the primary sources, however, plastics when splinters from larger plastic matter eg. by degradation, fragmentation, friction, under UV rays or very high temperature or sunlight, etc(Pironti et al. 2022), they come under secondary sources (Lehtiniemi et al. 2018)

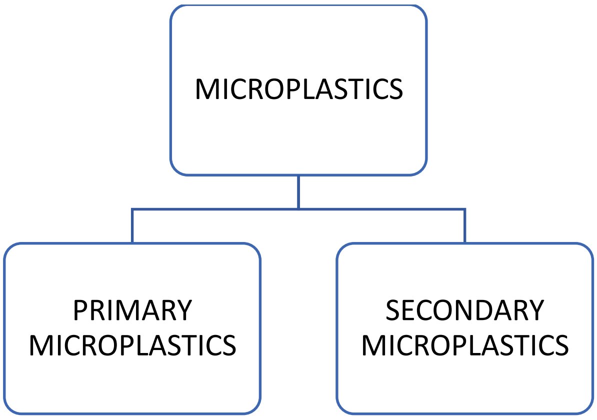


***Figure** 1 shows types of microplastics*

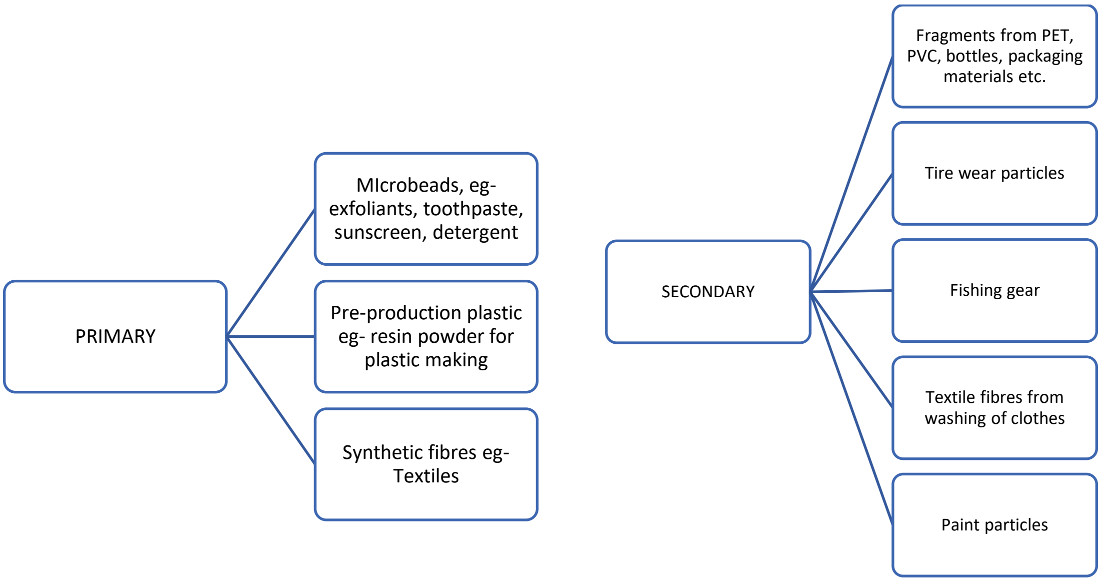


Figure2 showing primary and secondary microplastics

SOURCE OF MICROPLATICS

Intentionally manufactured microplastics, designated primary microplastics, include microbeads in personal care products and industrial abrasives for delicate surfaces. Microbeads are also used in cleaning agents, coatings and paints, drilling fluids in the oil and gas industry, and as precursor resins and pellets for the manufacture of finished plastic products. Secondary microplastics are formed from the fragmentation of larger plastics during usage (e.g., wear particles from tires) or after disposal. Secondary are far more abundant than primary microplastics. It has also been reported that majority of plastic fragmentation occurs on land due to greater ambient temperatures, frictional forces, and UV exposure.(Hale et al. 2020). Microplastics have been traced into human blood (Leslie et al. 2022), lactating mothers' milk, fetus, feces (Schwabl et al. 2019), human urine (Pironti et al. 2022) etc. A study done in China shows the presence of microplastics in table salt, which comes from the evaporation of saline sea water (Yang et al. 2015)

Microplastics are omnipresent and their diversity in size and shape, among which common forms are fiber, fiber bundle, fragment, sphere (or bead), pellet, and film, (Rochman et al. 2019) and discrete properties like large surface area, small size, and inert nature makes them easily fitted in any environment, place or surface and helps in interaction with other contaminants like heavy metals, antibiotics, pesticides, pathogenic microorganisms via sorption medium (Godoy et al. 2019), and can cause serious health issues if ingested by living beings (Naqash et al. 2020).The rate of degradation depends on various factors like pressure, temperature, light etc. to find the exact source of microplastics is a difficult task as it would require to go back to the source, location and time when the degradation began but since microplastics is constantly in dynamic motion and comes from diverse sources it is not possible to find exact source of a given microplastic (Wang, Zhao, and Xing 2021).

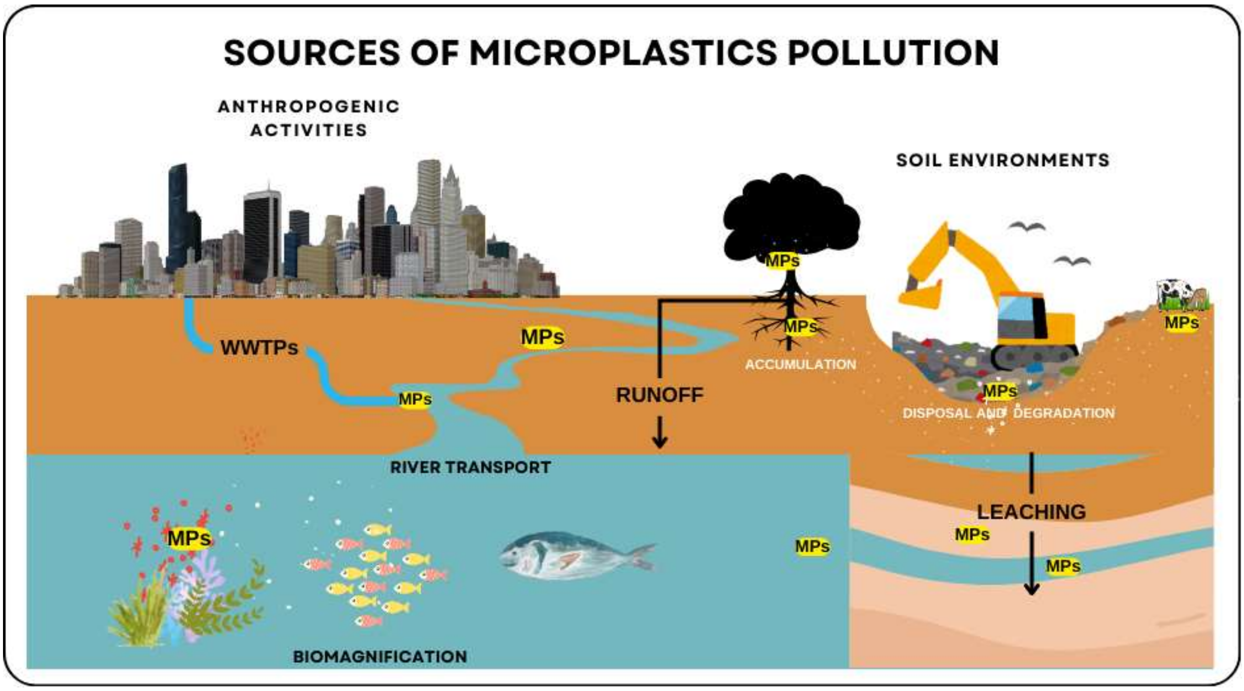


Figure 3 shows sources of microplastics in the environment.

MATERIAL AND METHOD

Materials used were sieve of size 0.5 mm, bottles, gloves, mgf whattman filter paper 1.2 micron, vacuum glass filter apparatus, petridishes, 250 ml flask, beaker, ph meter etc.

Chemicals required for sample preparation were ferrous sulphate salt, sulphuric acid, tween20 solution, 20% hydrogen peroxide solution.

Study site and sampling

Yamuna, a major tributary of Ganges originates from Yamunotri glaciers in the Himalayan range , north of Haridwar. The catchments of Yamuna river system cover parts of Uttar Pradesh, Uttarakhand, Himachal Pradesh, Haryana, Rajasthan, Madhya Pradesh & Delhi states.

It enters delhi near palla village. The Yamuna river segment in Delhi is about 22kms from Wazirabad barrage to okhla barrage.

The Najafgarh drain is the first major drain that joins the Yamuna River at Wazirabad in Delhi, India, and is known to contribute to the maximum pollution load to this river.

The drain is originally an extension of the Sahibi River and was intentionally constructed as a canal to carry stormwater, but presently, it is carrying more of sewage, agricultural, and industrial effluents received through various small and large secondary drains.

We precisely mapped its length and boundaries, along with identifying relevant anthropogenic activities within the catchment area.

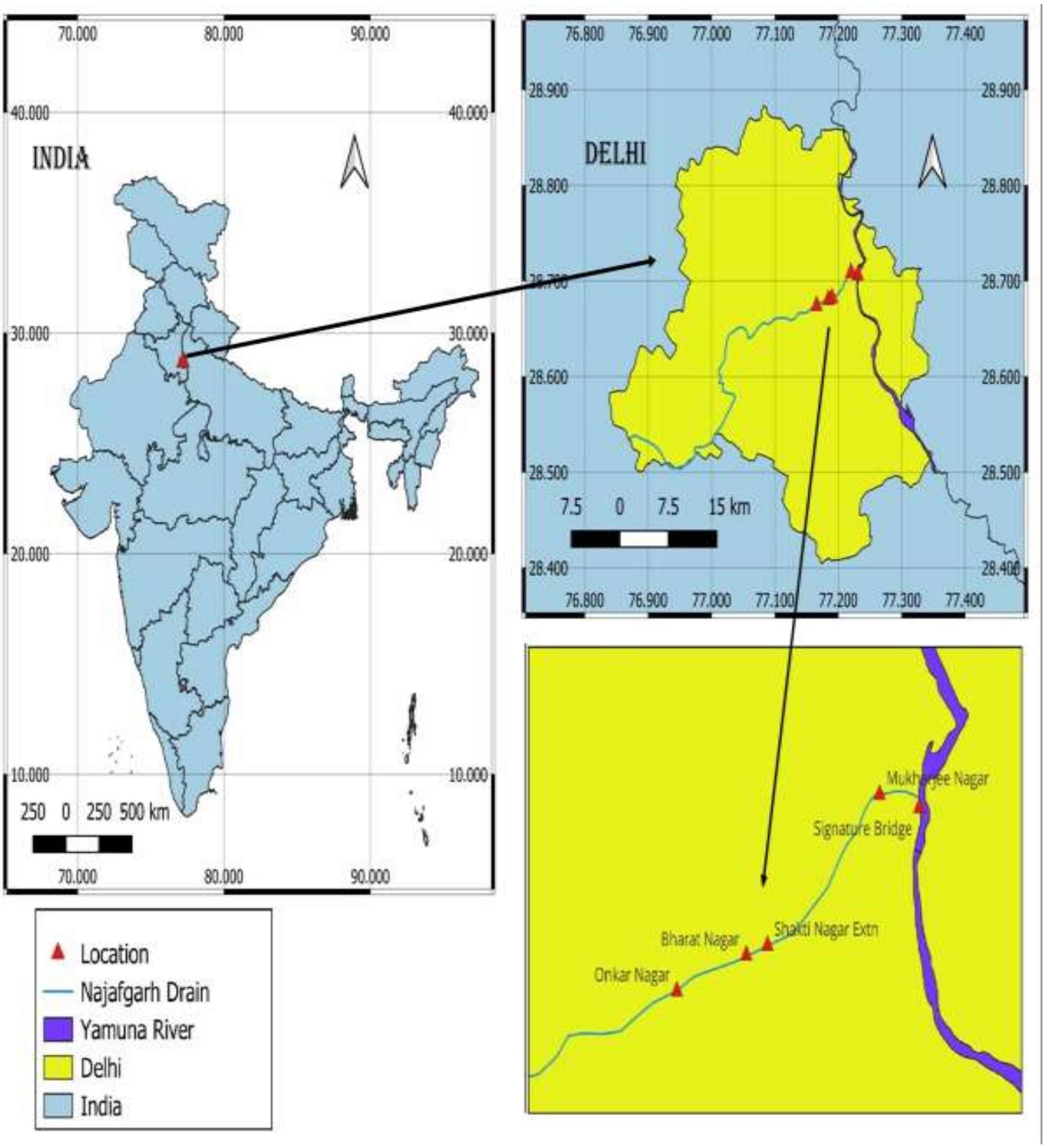


Fig 4 shows map of Najafgarh drain in Delhi.

The population density, river demographics, and wastewater sources are taken into account while choosing sampling locations. So that an accurate assessment can be performed with a minimum number of samples, one of the primary objectives of this study is to gather samples that are indicative of the site circumstances. To account for probable distribution of microplastic contaminants, multiple water samples were taken at several points, like Signature bridge, Mukherjee nagar, Shakti nagar Bharat nagar and Onkar nagar within the drain. The co-ordinates of the selected locations are listed in the table 3.1. The sampling locations were purposely selected approximately 200-1000 meter downstream locations.

Table 3. shows latitude and longitude of the sampling locations

SAMPLING SITES		LATITUDE	LONGITUDE
1.	ONKAR NAGAR	28.402207	77.093898
2.	BHARAT NAGAR	28.688058	77.184136
3.	SHAKTI NAGAR	28.682439	77.189514
4.	MUKHERJEE NAGAR	28.708992	77.219939
5.	SIGNATURE BRIDGE	28.706548	77.230568

Sample collection and preparation

Sample collection was done in the first half of the day between 9 am to 12pm were collected using grab sample method and transported to the laboratory for further analysis. The sampling bottles were washed thoroughly with distilled water to avoid any kind of contamination, the water samples were filled up to the brim and finally the samples were stored in an ice bath to maintain its temperature until it reached to the laboratory to be stored in deep freeze at -20° C to be analysed later.

Microplastics are pervasive pollutants that are found almost everywhere in the environment. However, because of the complex and varied analytical methodologies currently in use, understanding about sources, fate, and ambient concentration throughout time and place remains restricted. The lab analysis will offer information on gathering bulk samples, separating and digesting them, identifying and quantifying them, and reducing cross-contamination.

There are two methods commonly used to prepare the sample for microplastics analysis , Fenton namely Fenton method and KOH/peroxide method also known as wet peroxide method. The latter includes lesser chemicals but more time, however the prior needs more chemicals but gets done within the same day. The Fenton method is an exothermic process where temperature goes upto 90°. In this project we have used method as it was more feasible and less time consuming.

For the Fenton method a batch of ferrous sulphate was freshly prepared by mixing 10g of $FeSO_4$ to 500ml of distilled water. 2 ml of waste water sample which has been filtered using vacuumed glass filter to remove all gunk, dust and heavier materials is taken in a 250 ml conical flask, to which 10 ml of ferrous sulphate of pH 3 is added followed by 30% H_2O_2 solution. The exothermic reactions start at this point. Keep adding 5 ml H_2O_2 every minute for the next 10 minutes, precautions should be taken as the exothermic reaction leads to increase in temperature upto 90° C and at this point the solutions turns into brick orange colour. Leave the flask to cool down for about 10 minutes and add 4 ml of 98% H_2SO_4 , shake it and we see the solution turning transparent from brick orange. The final steps involve adding 10 ml of 0.1% tween20 solution. The solution is finally filtered over a microfibre filter paper of 0.2 micron, and is further sent for instrumental analysis.

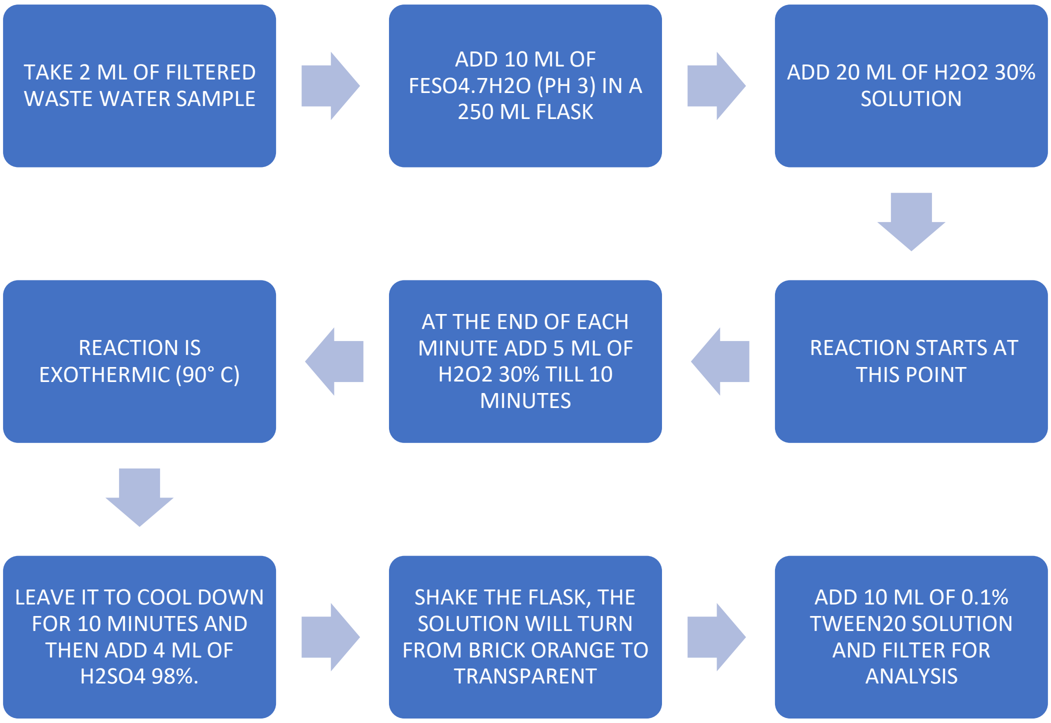


Figure 5 shows flowchart of Fenton process.

RESULT AND CONCLUSION

Microplastics under SEM gave a magnified image which otherwise cannot be seen with naked eyes. As can be seen in the figure 4.1, most common type of microplastics are fragment types, which maybe the result of years of transportation, and sunlight activity on the source product.

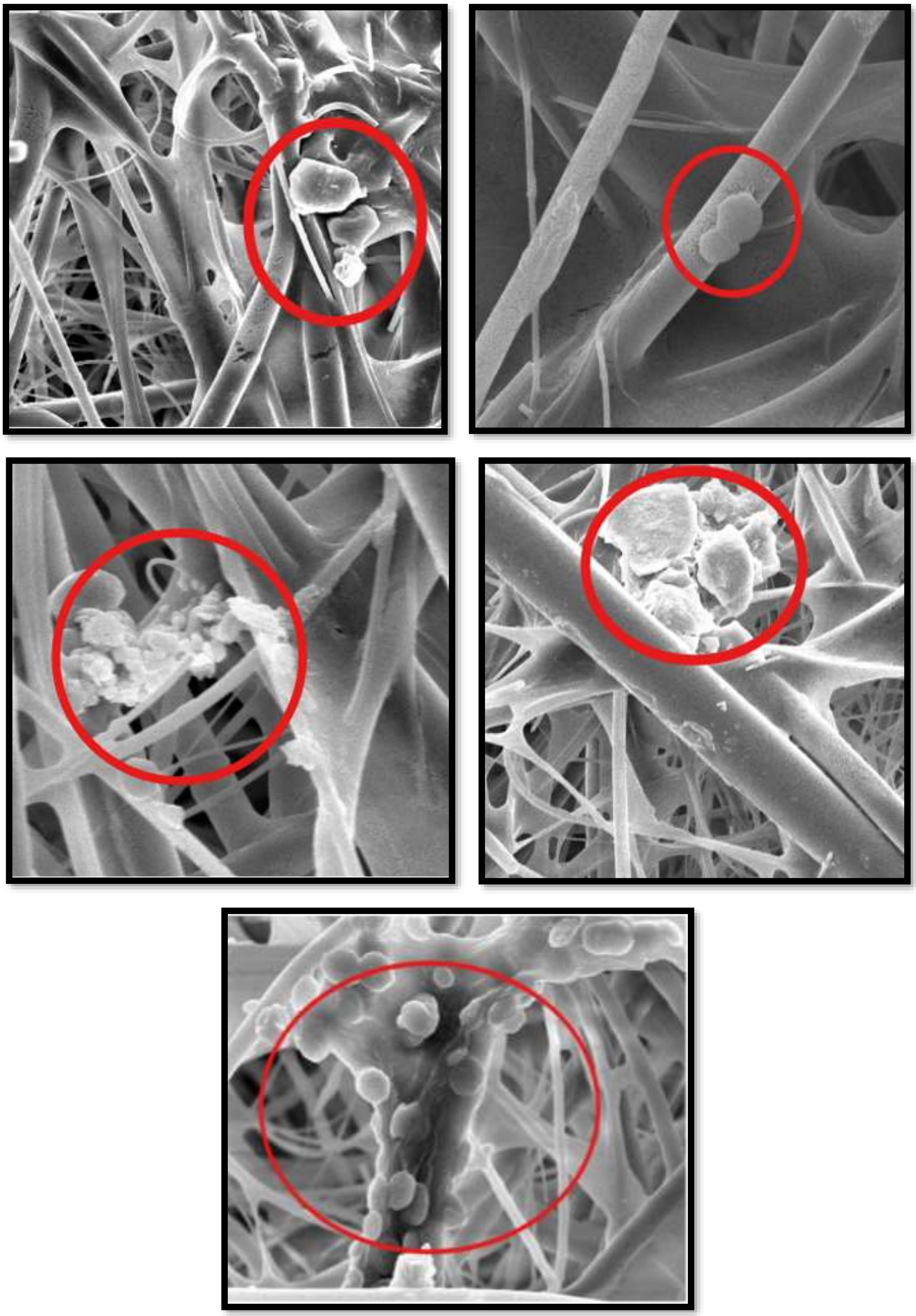
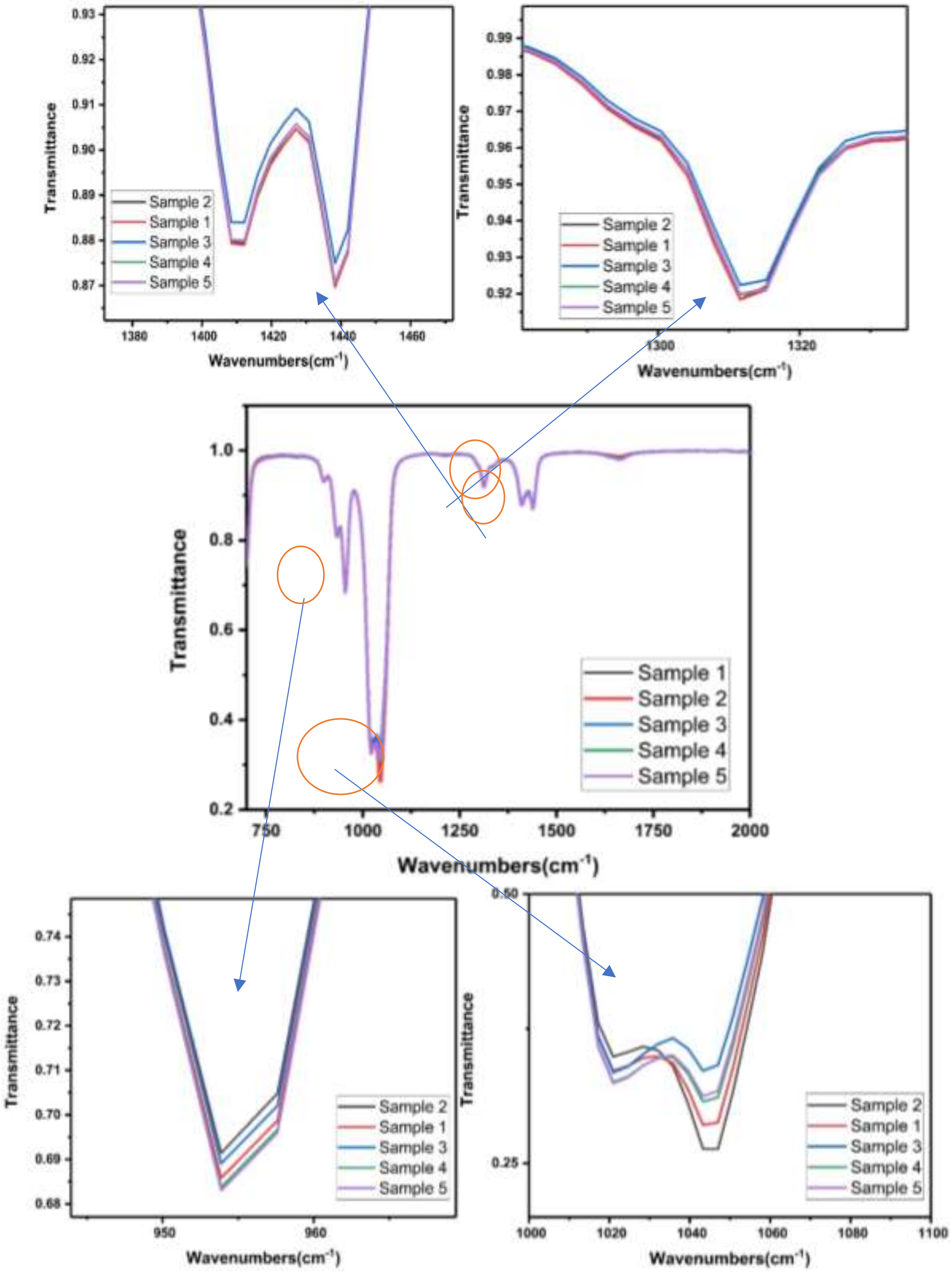


Figure 6 shows images of microplastics under SEM



We compared our peaks with the previous done studies and found an intresting similarity proving the presence of similar kind of MPs. The FTIR (Fourier-transform infrared spectroscopy) is a mighty analytical technique for qualitative analysis in the field of science, it helps in identifying the functional groups attached to the chemical and therefore helps in chemical representation of the product. It gives structural fingerprints of the substance and helps in identification of type microplastics which may be PET, PE, PP, PVC, and NY. The FTIR scan ranged from 650 to 4000 cm−1, as studied from the literature the highest peak value i.e peak (e) and (f) 1043.3 cm^{-1} and 1020.9 cm^{-1} which represents presence of corresponds to C-O bonds which indicates the presence of PET and PVC, two of very common types of microplastics. All the samples represent similar kind of microplastics as their common source is garbage, household waste, and trash usually drained out in the drain. The peaks occurring at wavenumber of 1438 cm^{-1} and 2999.4 cm^{-1} shows presence of

C-H bond which is mainly present in PP, PE, PS, which are commonly present in products like packing materials, storage boxes, textile fibres, bottles, bowls, and construction materials like insulation boards, etc.

CONCLUSION

Microplastic pollution in freshwater systems is primarily caused by human activities such as wastewater treatment, household waste disposal, and industrial effluent release. The distribution and fate of these pollutants are influenced by physical, chemical, and environmental factors, as well as river currents. In freshwater ecosystems, microplastic deposition and movement are slower than in marine environments due to factors like density, sediment properties, and hydrodynamics of water flow. Lower densities of microplastics move more within sediment layers, while higher densities aggregate near entry points. Bottom water flow velocity also influences the transport of microplastics, with swifter currents facilitating downstream dispersion. River sediments act as sinks, accumulating microplastics over time. Spatial variability in microplastic distribution, influenced by hydrodynamics, pollution sources, and sediment characteristics, produces "hotspots" with higher concentrations. These hotspots form in areas with specific environmental conditions or anthropogenic activities (Talbot et al. 2022).

The comprehensive analysis of microplastics using Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM) has yielded significant insights into the types, characteristics, and potential sources of microplastic pollution in the studied environment. The integration of these two advanced analytical techniques has provided a robust framework for identifying and understanding microplastics at both molecular and morphological levels. The FTIR spectra revealed the presence of key microplastic types, specifically polyethylene (PE), polypropylene (PP), and polystyrene (PS). Characteristic absorption peaks, such as the 1438 cm^-1 peak associated with CH2 bending, were instrumental in identifying PE and PP. Other distinct peaks, such as those around 2950 cm^-1 (CH stretching in PP) and 1492 cm^-1 (aromatic ring vibrations in PS), further validated the presence of these polymers. The SEM analysis gave a detailed description of morphology about microplastics and showed predominant presence of fragments of microplastics. The findings from this study underscore the pervasive nature of microplastic pollution and its complex interaction with the environment. The identified microplastics, especially the small-sized particles, pose significant risks to aquatic life and potentially to human health through bioaccumulation and trophic transfer. The degradation features observed on the microplastics' surfaces indicate ongoing fragmentation and weathering, suggesting that the pollution levels could worsen over time.

This study will further help in source identification of microplastics to specific industrial, domestic or environmental source and help in forming mitigation strategies. This thesis has demonstrated the efficacy of combining FTIR and SEM for a comprehensive analysis of microplastics. The detailed molecular and morphological insights obtained have provided a clearer understanding of the types, sources, and potential impacts of microplastic pollution. These findings contribute valuable knowledge to the ongoing efforts to address and mitigate the challenges posed by microplastics in our environment.

In conclusion, the study reinforces the urgent need for continued research and proactive measures to combat microplastic pollution, ensuring the protection of environmental and public health for future generations.

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