ISSN No:-2456-2165

Microplastics are Ubiquitous, but their Deleterious Effects are a Serious Concern to Our Environment – A Mini Review

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Abstract:- Microplastics (MPs) is Present everywhere from the great Himalayas to deep oceans. It is a new type of pollutant in our environment. Microplastics are polymers plastic particles that are synthetic or semisynthetic and have an average size of less than 5mm. On an average 11kg of plastic is consumed per capita in India which is 9 times smaller than per capita consumption in America. 100 million plastic bottles are used per day by the whole world. The COVID-19 pandemic has led to an overabundance of microfiber waste, Personal Protective Waste (PPE), primarily from hospitals, homes, schools, streets, river garbage, and other locations throughout the world. There are several types of analysis and quantification methods used to accurately determination of microplastics Such as microscope, µ-FTIR spectroscopy, µ-Raman spectroscopy, ATR -FTIR spectroscopy, Pyrolysis gas chromatography/mass spectrometry, etc. Microplastic contamination becomes a growing concern in every aspect of our environment yet there have been comparatively few studies in India. Marine systems have received much more attention than other compartments such as fresh water, air, terrestrial, and human consumables in the overall number of studies published on microplastic prevalence in Indian Habitats. The purpose of this paper is to provide a better understanding of the evaluation of previously conducted studies. We intend to make a significant step towards the harmonization of microplastic particle analysis in all environment matrices.

***Keywords*:-** *Microplastics, µ-FTIR Spectroscopy, Plastic Bottle, Synthetic, Fresh Water, Environment Matrices.*

I. INTRODUCTION

Plastic debris is present in the environment in a wide range of sizes, according to the United Nations Environment Programme (UNEP). In the 1970s, researchers discovered microscopic beads and fragments of plastic, particularly polystyrene, in the ocean water. In the mid-2000s, the term "micro plastic" was invented to describe any tiny plastic particle with a diameter of 2.5 mm (0.2 inches).

Polymers have been employed to manufacture various materials for the past 70 years, including plastic bottles, bags, water pipes, packaging products, and so on. Because of its qualities like as low production cost, great durability, moisture resistance, light weight, and good thermal and electrical insulation properties, it has become unavoidable in modern life. This results in a large amount of plastic waste being released into the environment (*Andrady et al 2011; Thompson RC et al 2004; Proshad et al 2017*).

Microplastic contamination is increasing day by day in the current scenario. According to the most recent studies, microplastic is found in practically all aquatic environmental sectors, including saltwater (*Schonlau et.al.2020; Lorenz et.al. 2019*) Water from a river (*Simone Lechthaler et.al.2021*) Sediments, (*Kannaiyan Neelavannan et.al. 2022; Sajimol Sundar et.al. 2021; Goswami et.al. 2020; Patel et.al. 2020*), ground water (Ganesan et.at.2019), and surface water (*Ganesan et.at.2019*) are all used for drinking purposes around the world, but recent research has shown that contamination has increased (*Amrutha & Warrier 2020*). Microplastics have also wreaked havoc on our air (*Barletta et.al 2019*), food, drinking water, and humans.

288 microplastic particles were identified in 11-tap water samples of Goa city, according to the Indian Express (2021) study report, and contamination can occur during the transmission process because most water pipelines are composed of PVC. In a drinking water distribution system, plastic pipes can be a substantial source of microplastic. Another report published by the United Nations news agency (2021) stated that, plastic makes up 85 percent of all marine garbage. If things keep on this way, the outcome will be disastrous. Plastic pollution in the ocean is estimated to double by 2030 and triple by 2040, resulting in an annual increase of 2327 million metric tonnes of garbage. This equates to around 50kg of plastic every meter of beach.

According to *Paulo A. Costa Filho et al.* (2021), this is the first time that a relatively low amount of small size (5mm) has been reported in raw milk collected at a farm just after the milking machine, and accumulation of small polystyrene microplastic in the liver, kidney, and gut was observed in mice (*Deng et al. 2017*). According to latest studies conducted by Leslie and his team in 2022, Microplastics have been discovered in human blood stream. He detected various class of micro plastic in 17 blood samples out of 22. However, it would be wrong to say that humans are not yet threatened by microplastic contamination. Studying is increasing in this field, and indications of malice towards humans are also increasing .

The ongoing COVID-19 pandemic has had a substantial impact on human health, as well as the crisis of the country's economy and daily life. As the COVID-19 pandemic continues to spread, to stop the growth of the sickness, Face masks are used as the primary personal protective equipment (PPE). the manufacture and use of face masks have increased considerably. Most of these face mask wastes comprise polypropylene and/or polyethylene, polyurethane, polystyrene, polycarbonate, and polyacrylonitrile, which pollute the environment with microplastic pollution (*Akber et al., 2020, de Sousa 2021*).

This implies that the current pandemic is increasing pollutants in the environment and having a negative influence on human and animal health (*Parashar et. al. 2021*).

Sarkar et al. (2020), Panday *et al. (2021)* and *Vaid et al. (2021*) presented three review articles based on the current survey about the presence of MPs in different environmental sectors of India. This review is an attempt to add to the existing body of knowledge.

II. TYPES AND SOURCE OF MICRO PLASTICS

Micro plastic has classified into two class; primary and secondary micro plastic, Different definition has been used in the Literature (*Lassen et.al. 2015*) and We adopt a following as proposed by a Norwegian study (*Sundt et.al. 2014*)

Primary microplastic -It is directly entering into the environment in the form of small particulates Examples- plastic palette, personal care products, cosmetics (e.g. - shower gel).

Secondary microplastic -The breakdown of larger plastic items into smaller plastic fragments (*Thomson RC (2015)*, this happen when larger plastic undergoes weathering Example wind abrasion and UV radiation from sun light.

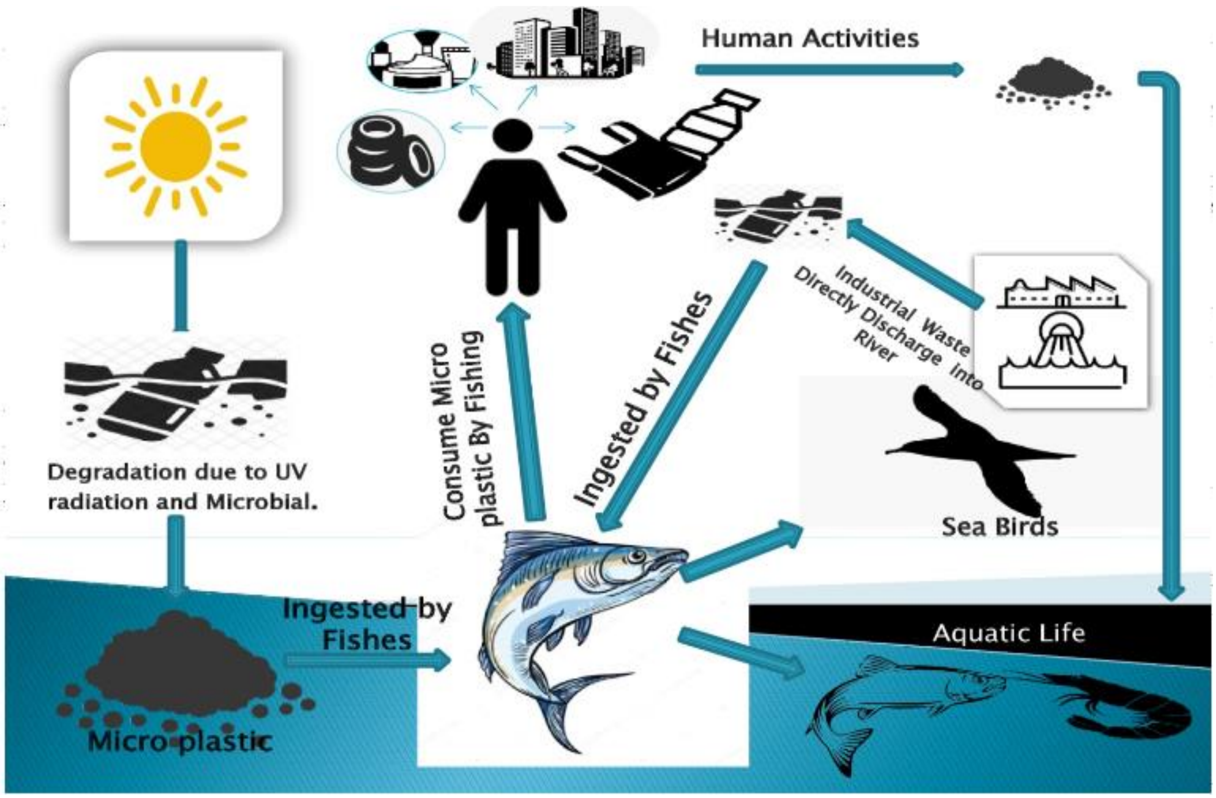

Fig 1- Showing the distribution of microplastic**.**

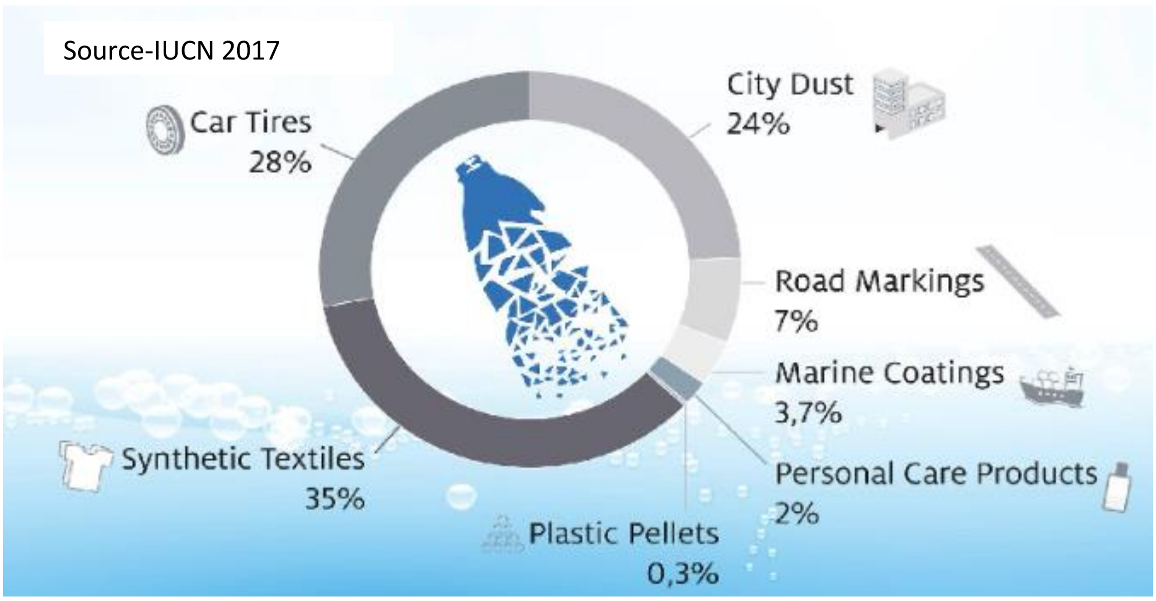

Fig 2- Primary microplastics released into the world's oceans on a global scale.

A. Key source of microplastic-

- **Plastic pellets-** Manufacturing Industries produces several plastics in the shape of pallets, typically 2-5 mm in diameter or Powder, in their primary form. Many studies have been investigated the occurrences of plastic palette. They are also called nips, nurdles, mermaid tears (Sundt *et al 2014*).
- **Personal Care Products-** Many cosmetic and personal care product include a type of micro plastic known as micro breeds which include scrubbing agent, shower gels and creams etc.
- **Car and Truck Tyres**: **abrasion on the streets -** Tires degrade over time and rubber dust is produced, which can be distributed by the wind or rinsed off the road by rain.
- **Industrial Effluents (Synthetic textile)-** Polymer Industries waste which are released into canals, rivers and oceans are the possible way of MPs contamination in drinking Water.
- **Road Makings -** During the application of various forms of road markings (paint, polymer tape, epoxy), micro plastic may be lost due to weathering or abrasion by automobiles, and as a result, micro plastic spreads into the environment via air or water.
- **Marine Coating-** Coating are applied to all part of vessels for protection from corrosion, various type of plastics is used for Marine coating like polyurethane and epoxy coatings etc.
- **Dumping of plastic product in the river, ocean, and soil-** Direct dumping of plastic debris in the various areas and decomposition of these plastic debris are results in MPs in air and aquaculture.

B. Identification Methods of Micro plastics

Microplastics are very small in size. It is therefore difficult to identify different size and polymer types of micro plastics in complex environment matrices so many researchers have used more than one analytical technique. In general micro plastic analysis consist of two steps: physical and chemical analysis. Which is described in figure 3,4.

Figure -3,4 Currently used Physical and chemical methods for microplastic analysis.

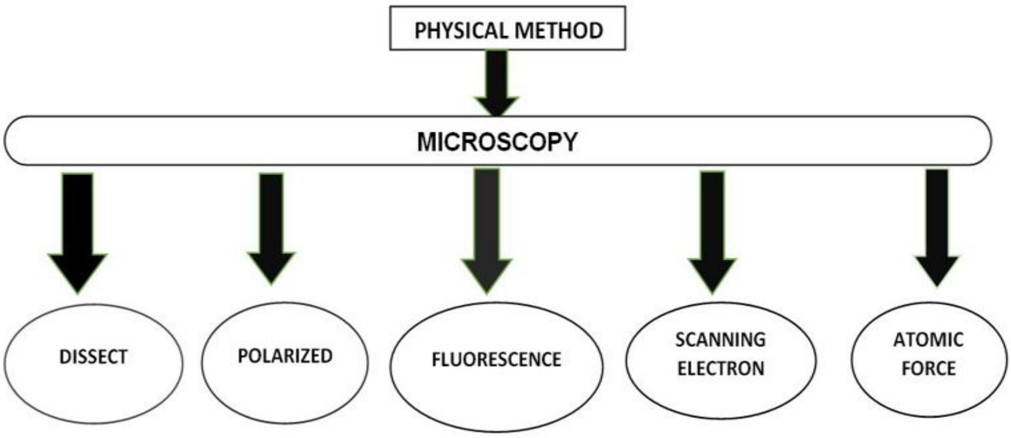

Fig - 3

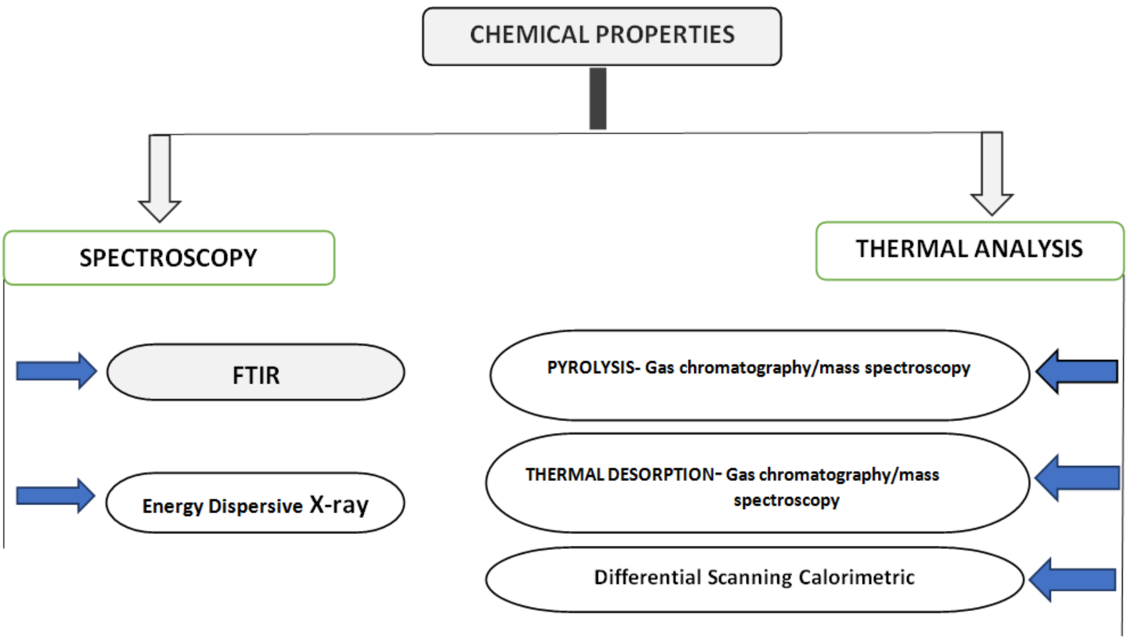

Fig - 4

Table -1. Pro and Cons of the currently used microplastics identification method.

Identification methods	Pro	Cons
Microscopy	Simple, fast, and easy.	- There is a substantial chance of a false positive. -No chemical conformation. -No polymer composition data.
FTIR spectroscopy	-No external calibration is required and gives accurate results -Non destructive analysis - It can detect even the tiniest traces of microplastics pollution(<10mm) - FTIR can be used to analyse gases, solids, and liquids	- Expensive instrument - Whole particle identification is a time-consuming and difficult task.
Raman Spectroscopy	-No sample preparation needed. -Not interfered by water. - Non destructive. - MPs as small as 1mm can be detected.	- can not be used for metal or alloy -Expensive instruments - Sample heating through the intense laser radiation can destroy the sample or cover the Raman spectrum
Thermal Analysis	- Simultaneous pyro-GC/MS analysis of polymer type and additive mixtures.	-Destructive analysis. -A few polymers identification. -Complex data

III. LITERATURE REVIEW

A. Microplastic Pollution in Aquatic Environment

➢ *Marine Sediments*

When the density of Microplastics exceeds that of seawater (> 1020 kg/m3), they begin to accumulate in benthic layers, particularly sediments; otherwise, they float on the surface (*Cauwenberghe et al. 2015.* MPs have been found within the marine sediments of Gujarat, Tamil Nadu, Goa, Pondicherry, Maharashtra, Kerala, Karnataka, Andaman and Nicobar Islands, and Lakshadweep. In the anchar lake of the northwest Himalaya, fibres (91%) were the most common shape group in the sediments, followed by fragments/films (8%), and pellets (1%) (*Neelavannan et.al 2021*). MPs on beaches/rivers/lakes are caused by a variety of natural and manmade factors. Natural sources include surface and wind currents, aeolian processes, and run-off transport, while man made factors include fishing, tourism, recreational, religious, port, and industrial activities, unmanaged plastic trash, and untreated wastewater discharges. (Veerasingam *et.al2016b: Neelavannan et.al 2021*) MPs were identified using Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) spectroscopy, but other methods such as fluorescence microscopy with Nile red dye (*Patchaiyappan et al. 2020a*), Raman spectroscopy (*Dowarah and Devipriya 2019*), and gravimetric analysis (*Arbind Kumar Patel et al. 2020*) were also used. Table-2 summarizes the findings of these research. This issue necessitates that the relevant stakeholders take the required efforts to standardize Microplastics sampling and analytical processes at both the national and global levels, to synchronize the development of microplastic databases for various environmental matrices.

➢ *Rivers*

According to recent research by Napper et al. (2021), the Ganges, Brahmaputra, and Meghna rivers discharge around 1–3 billion MPs daily into the Bay of Bengal. The channelization of these synthetic polymers to different portions of the water column is facilitated by differences in hydrodynamic and climatic parameters such as wave height, flow velocity, and wind speed (NPC 2020).

- *Case Study of Yamuna and Ganga River*

Location Name	Sample Code	Location Code in above figure
River Yamuna: Yamuna boat club, Naini bridge, Prayagraj	ALYU0802	A1
River Ganga, Prayagraj	ALGU0802	A7
River Ganga, Prayagraj	ALGD0802	A8
Confluence point (Sangam), Prayagra	ALLSD0802	A5
Kailash Ghat, Agra	AGYU1202	AG3
Dussera Ghat, Agra	AGYD2102	AG4

Fig 5- Location of the different samples.

According to the National Productivity Council (NPC) Micro-plastic surveys were conducted in the Yamuna River on the 21st and 12th of February 2020 in Agra, and on the 08.02.2020, at Prayagraj, on the Ganga, Yamuna, and Sangam. The following are the locations of micro-plastic sampling depicted in figure 5. The samples were collected using a Neutson Net with a mesh size of 300 micrometres, and the microplastics were detected using an FTIR Microscope (figure 7).

Conclusion of this case study - Plastic garbage, primarily single-use and secondary plastic products, was found in the river waters chosen for the study. Plastic trash was discovered in and around riverbanks, with its harmful influence seen in river as floating litter. The river takes all the waste and sewage wastewater from the city and discharges it directly into the river. The number of microplastics found in River Ganga A8 (5.69 MPs/m^3) was much greater than in any of the other locations, followed by the Yamuna River in Agra (AG4 and AG3), which had 4.62 and 4.00 MPs/m^3 respectively. Sangam in Prayagraj A5 had the lowest MPs concentration (1.23 MPs/ m^3), followed by another Ganga sample in Prayagraj A7 (1.47 MPs/ m^3), and Yamuna in Prayagaraj had a reasonably high concentration (2.43 MPs/ m^3) (A1).

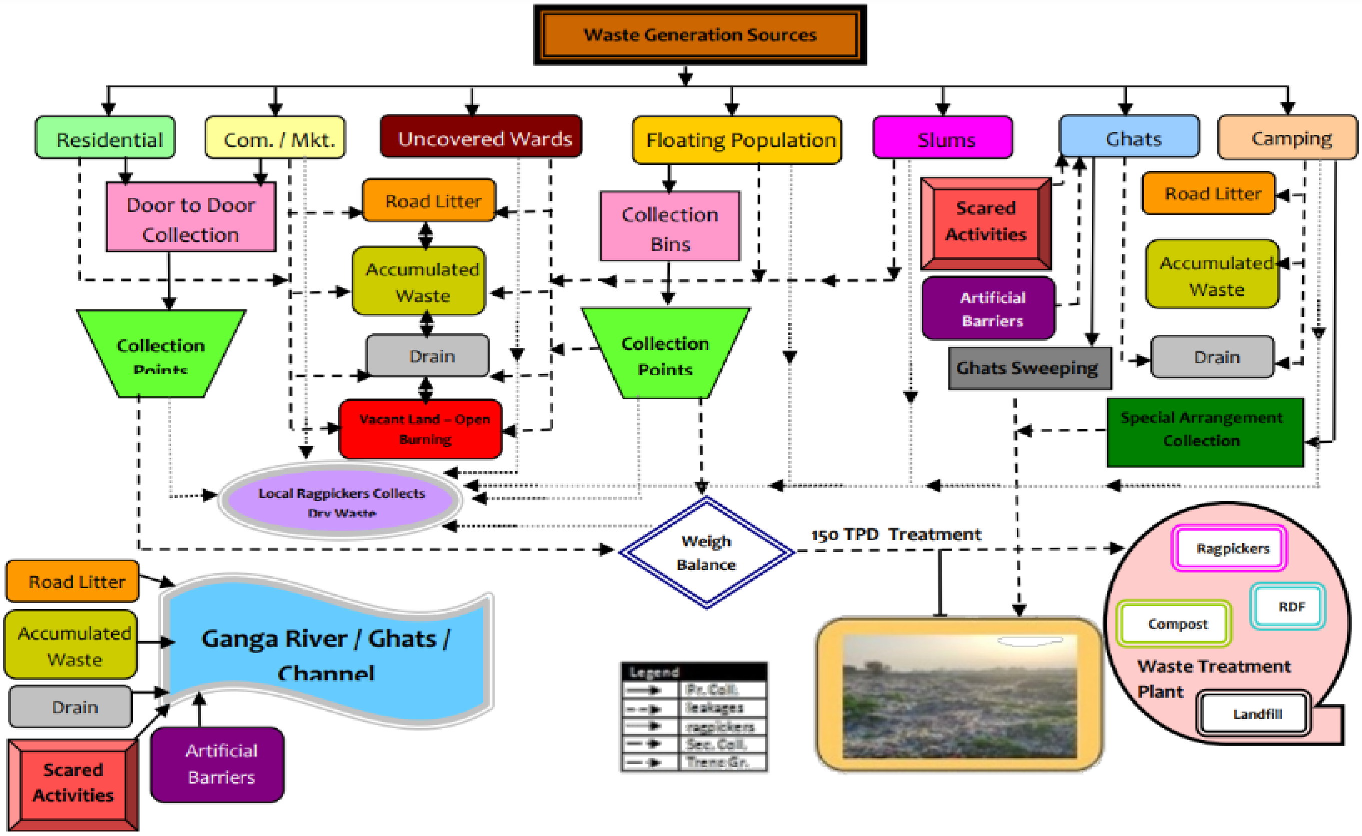

Fig 6- Flow Diagram of Plastic Waste Generation and Leakages. (Source – NPC 2020)

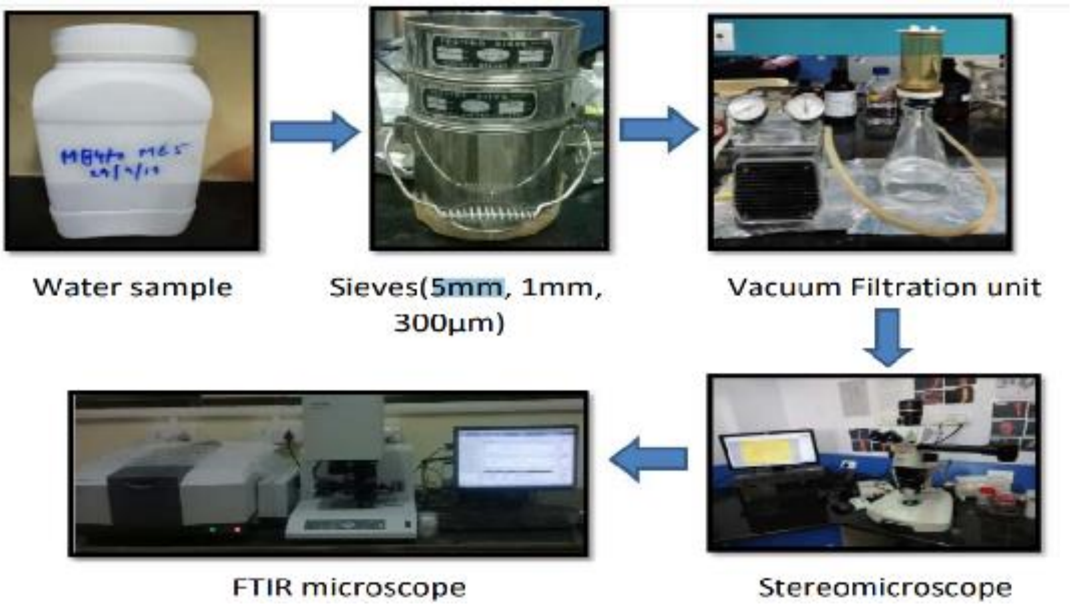

Fig 7- Pictorial flow chart of micro plastic sampling. (Source-NPC2020)

B. Microplastic -as a boon and a curse on Human Health.

According to several research. Microplastics from the environment entered the food chain through plastic goods used in food storage and transportation. Microplastic contamination of human organs has been documented in recent studies from a variety of industries and nations. Microplastic contamination was discovered in 17 out of 22 human blood samples (Leslie et al.2022), 11 out of 13 human lung tissue samples (L.C. Jenner et al.2022), and 4 out of 6 human placenta samples (A. Ragusa et al.2020). Some of the approaches used to identify and characterise microplastics in human organs include Py-GC/MS, micro-Raman spectroscopy, and micro FTIR- SEM-EDS. In human lung tissue, there are 39 different forms of microplastics (L.C. Jenner et al.2022), 12 microplastic pieces in the human placenta (A. et Ragusa al.2020), and various Polymer MPs contaminants are found in human blood and the internal organs most affected are the liver, kidneys, heart, nervous system (including the brain) and the reproductive system (Cingotti et al 2019). Table-2 summarizes the findings of these research.

*Most of the national and international research has been done on micro plastics from 2013 to 2022. his description is given in table -2.

Table-2. Microplastics abundance, kinds, and sources from diverse areas were studied.

S NO	Area of study	Source of samples	Used Methodology	Abundance of micro plastics	Class of micro plastics *	Author
1.	Switzerland	Milk	Micro Raman spectroscopy	204- 1004mg/ 100ml	PE, PS, PP, PES, PTFE, PA, PU, PSU, PVA	*Paulo A. Costa Filho et. al (2021)*
2.	UK	Lung tissue	Micro-FTIR spectroscopy	1142± 1.50mg/g	PP, PET, Resin	*Lauren C. Jenner et al. (2021)*
3.	Italy	Human placenta	Micro Raman spectroscopy	23 g MPs/ 600g placenta	PP and pigments	*Antonio Ragusa et al. (2021)*
4.	Netherlands	Human blood	Py-GC/MS	1.6mg/ml	PET, PP, PS AND PE	*Heather A. Leslie et. al (2022)*
5.	Malta	Sandy Beaches	Flame test coupled with density measurements	0.72-10.81 items/ 1000m³	PE, PP, paint pigments	*Victor Axiak et al (2017)*
6.	Italy	Costal water	3T3-L1 PR adipocytes	1.88 ± 1.78 items/m³	PCBs, PAHs, OP, OC, Pesticides	*Panday et al. (2022)*
7.	Banaras, India	Air and street dust	FTIR, py-GC/MS		PE	*Martina Capriotti et al (2019)*
8.	India (Ganga River)	Sediments	Microscope and ATR- FTIR	107.57 -409.86 items/kg	PET, PE, PP, PS	*D.J. Sarkar et. al (2019)*
9.	Puducherry	Sediment	Microscope and Raman spectroscopy	72.03 ± 19.16 items/ 1000g	PP, HDPE, LDPE, PS, PU	*Dowarah & Devipriya (2019)*
10.	Andaman	Sediment	Raman spectroscopy	414.35± 87.4 items/ kg	PV, PVC	*A.Patchaiyappan et. al (2020)*
11.	Rameswaram and Gulf of mannar	Sediment	Stereo Zoom binoculars microscope and FTIR	403items / kg	PP, PE, PE, NY, PVC	*A.Vidyasakar et al (2018)*
12.	Tuticorin	Sediment	Microscope and a ATR-FTIR	25± 1.58 to 83± 49 items/m²	NY, PE, PP, PS, PET, PVC	*K.L. Jeyasanta et al 2020*
13.	Sabarmati River, Gujarat India	Sediment	Gravimetric analysis	134.53kg^{-1} to 581.70mg.kg^{-1}	Plastic Debris and Fiber	*Patel, Arbind et al. 2020*
14.	Port Blair Bay and Andaman Islands	Zooplankton	Microscope and FTIR	27/30 samples (90%)	NY, PU, PVC	*P. Goswami et al (2020)*
15.	Bay of Bengal	Fishes	Microscope and FTIR	20 items in 17 fishes	PE, PET, PA	*P.K. Karuppasamy et al (2020)*
16.	Puducherry	Bivalves	Raman micro spectroscopy	0.18 ± 0.04 to 1.84 ± 0.61 items/ g	PU, PVC, PES, PET	*Dowarah et al(2020)*
17.	Tuticorin	Fishes	FTIR	0.0002 ± 0.0001 to 0.2 ± 0.03 items /g	PE, PS, PA	*M.N.Sathish et al.(2020b)*
18.	Tuticorin and Gulf of Mannar	Oyster	ATR-FTIR and SEM-EDS	5.21± 4.85 to 9.74± 8.92 items/ individual	PP and PE	*Patterson et al (2019)*
19.	Kerala cost	Fishes	ATR-FTIR	15/70 samples	PE, LE, RY, PP	*Robin et al (2020)*
20.	Cochin, Kerala	Shrimps	FTIR	0.39 ± 0.6 items/Individual	PE, PS, PP, PA	*D.B.Danial et al (2020)*
21.	Mumbai	Sediment	-	194.33± 46.32	-	*H.B. Jayasiri et*

				items /m^2		*al(2013a)*
22.	Patna	Indoor dust	HPLC-MS/MS	4 ± 0.6 itmes /100 m^3	PET, PC	*Zhang et al (2020)*
23.	Kerala, Gujarat, Maharashtra	Salt	µ-FTIR	56± 49 to 103± 39 items/ kg	PE, PET, PS, PES, PA	*C.K. Seth et al (2018)*
24.	Himalaya India	Sediment	ATR-FTIR	606± 360 MPs/kg	PA, PET, PS, PVC, PP	*Neelavannan et al (2021)*
25.	Kuwait	Indoor Aerosol	µ-Raman spectroscopy	3.2 to 27.1 particles/m^3	-	*Saif Uddian et al (2022)*
26.	Goa	Sediment	ATR-FTIR	1655(SW monsoon) ,1345 (NE monsoon)	PE, PP	*Veerasingam et al(2016b)*
27.	India	Aquatic environment, biota	ATR-FTIR, µ-Raman spectroscopy and SEM-EDAX	3096 items/ kg in marine sediments, 106 items/kg in biota and 288 prices/m^3 in river	PP, PS, PVC, PC	*Karthikey et al (2021)*
28.	Chennai, Mannar , India	Water	FTIR	1.82 particles/ L	PP, PE, PET, PS, PMMA, PA, PU	*Simone et al (2021)*
29.	Dutch	Surface water	ATR-FTIR	67 to 11532 MPs/m^3	PE, PP, PVC, PS, PA	*S.M Mintening et al 2020*
30.	Spain	Aquatic environment	µ-FTIR and µ-Raman spectroscopy	0.12mg/L to 95mg/L	HDPE, LDPE, PET, PVC	*Alicia et al (2022)*
31.	Germany	Water	Micro Raman spectroscopy	-	PE, PP, PET, PS	*Felix et al (2021)*
32.	Tuticorin (Tamil Nādu)	Water	FTIR, SEM-EDAX	3.1 to 23.7 items/L	PE, PA, PS, PP, PVA, PEST	*Satish MN et al (2020)*
33.	Veeranam lake (Kerala)	Surface water	ATR-FTIR	28 items/km^2	PE, PP, PVC, PS, NY	*Manikanda et al (2020)*
34.	Yamuna river Agra (Uttar Pradesh)	Surface water	FTIR	4.0×10^{-3} to 4.62×10^{-3} items/L	PIP, EVOH, PA, PVC, PC,PP, PMMA	*NPC (2020)*
35.	Yamuna river (Prayagraj)	Surface waters	FTIR	2.43×10^{-3} items /L	PIP, PVC, PVAL, PA, PP, PVB	*NPC (2020)*
36.	New Delhi	Tap water	Microscope	4.34 items/L	PBDEs, PCBs	*Kosuth et al (2017)*

***Abbreviation -**

*MPs – micro plastics
*PE – polyethylene
*PS – polystyrene
*PP- polypropylene
*PES- polyether sulfone
*PTFE- poly tetra fluoro ethylene
*PA- polyamide
*PU -polyurethane
*PSU- poly sulfone
*PVA – polyvinyl acetate
*PET – polyethylene terephthalate
*PCBs – polychlorinated biphenyls
*PAH.s – polycyclic aromatic hydrocarbons
*OP- opaque polymers
*OC- organic carbons
*HDPE – high density polyethylene
*LDPE- low density polyethylene
*PVC – polyvinyl chloride
*NY – nylons
*LDP-low density polyethylene
*PMMA- poly methyl metha acrylate
*PEST- polyester
*PIP – polymer infiltration pyrolysis
*EVOH – polyvinyl alcohol
*PVAL- polyvinyl alcohol
*PVB – polyvinyl butyryl
*PBDEs – polybrominated diphenyl ethers
*MPs- Microplastics
*FTIR – Fourier transform infrared spectroscopy
*ATR-FTIR – attenuated total reflectance-Fourier transform infrared spectroscopy
*Py-GC/MS- Pyrolysis gas-chromatography mass spectrometry
*SEM-EDS- scanning electron microscope-energy Dispersive Spectroscopy

*HPLC- MS/MS- high performance liquid chromatography and tandem mass spectrometry

*SEM-EDAX - **Scanning Electron Microscopy and Energy Dispersive Spectroscopy**
.
*3T3-L1 PR adipocytes - 3T3-L1 is **a cell line derived from (mouse) 3T3 cells** that is used in biological research on adipose tissue

IV. CONCLUSION

India is one of the world's leading producers of plastic garbage. But India's contribution to global microplastic contamination is still unknown. The threats of MP pollution, as well as its mobility and deposition in the environment (terrestrial, marine, and atmosphere), are being studied all over the world, but India has a small fraction of this global database. This is an issue that is slowly gaining traction in India. The majority of studies have been undertaken in the marine environment, despite the fact that a large amount of plastic debris has been deposited on land-based sources. From the extraction of current studies, we have a vast area of investigation for the detection of microplastics in air, soil, food, and the human body. There are different approaches to increase the effectiveness of methodology, detection, and quantification of microplastics and Nano plastics through various studies. We believe that the current research will pave the path for future environmental research in a variety of areas.

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