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Review

Unveiling the Tiny Invaders: A deep dive into microplastics in shrimp – Occurrence, detection and unraveling the ripple effects

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ABSTRACT

Aquaculture is a rapidly expanding food sector worldwide; it is the farming of fish, shellfish, and other marine organisms. Microplastics (MPs) are small pieces of plastic with a diameter of less than 5 mm that end up in the marine environment. MPs are fragments of large plastics that take years to degrade but can frustrate into small pieces, and some commercially available MPs are used in the production of toothpaste, cosmetics, and aircraft. MPs are emerging contaminants; they are ingested by marine species. These MPs have effects on marine species such as growth retardation and particle translocation to other parts of the body. Recently, MPs accumulation has been observed in shrimps, as well as in a wide range of other scientific reports. So, in this study, we review the presence, accumulation, and causes of MPs in shrimp. These plastics can trophic transfer to other organisms, changes in plastic count, effects on the marine environment, and impacts of MPs on human health were also discussed. It also improves our understanding of the importance of efficient plastic waste management in the ocean, as well as the impact of MPs on marine biota and human health.

1. Introduction

Aquaculture has been the inevitable and fastest-growing food sector in the world over the last four decades; it is the cultivation of fish, shrimp, shellfish, and other organisms in various bodies of water under controlled conditions (Meyer, 1991). Aquaculture production and global fishers increased from 1.5 % to 184.6 % million tons in 2022, according to the United States Food and Agriculture Organization (FAO) (Halim and Nabi, 2022). Many scientific reports are being established on growth, new technology for aquatic species cultivation, harvesting, and technical issues encountered during the process (Afewerki et al., 2022). Shrimp farming has the potential to harm the aquatic environment and coastal areas through habitat destruction, waste disposal, pathogen invasion, and plastic accumulation (Naylor et al., 2000). This habitat destruction can have a significant impact on shrimp because they are more sensitive than other species and cannot withstand sudden temperature and climatic changes (Harley et al., 2006). Plastic wastes end up in water bodies and are ingested by most aquatic organisms, including shrimp causing growth retraction, oxidative stress, and other problems (Li et al., 2016).

Plastics are semi-synthetic materials that are used for all of life's basic needs because they are inexpensive, durable, and easy to carry (Millet et al., 2018). Plastics will become brittle and break into small fragments after prolonged exposure to sunlight, and they will remain in the marine environment (Gewert et al., 2015). Microplastics (MPs) are small plastic fragments with a diameter of less than 5 mm (Wagner et al., 2014). Polyethylene (PE), Polyethylene Terephthalate (PET), Polyvinyl Chloride (PVC), Polystyrene (PS), and Polypropylene (PP) are the most commonly reported MPs in water bodies and marine organisms (Oni et al., 2020). These ingested MPs cause growth retraction, oxidative stress, and toxicity in aquatic organisms, and these MPs block the gastrointestinal tract, resulting in starvation and physical deterioration, which eventually leads to the death of the organism.

Many studies show a correlation between MPs in aquatic organisms and water bodies with similar amounts of plastics; Qu et al suggest that the presence of MPs in mussels is derived from the small size of MPs in their surrounding water bodies (Qu et al., 2018; Rezania et al., 2018). The presence of polystyrene in shrimp causes retraction of growth, lethal effects on shrimp, and efficiency of feeding to offspring decrease in swimming efficiency (Wang et al., 2020). PE and PP fragments were

Abbreviations: MPs, Microplastics; FAO, Food and Agriculture Organization; WWTPs, Waste Water Treatment Plants; PE, Polyethylene; PET, Polyethylene Terephthalate; PVC, Polyvinyl Chloride; PS, Polystyrene; PP, Polypropylene.

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exposed to grass shrimp with bacterial infection for 96 h, resulting in no MPs ingestion in shrimp with infection (Leads et al., 2019). Polystyrene ingestion is seen in Artemia parthenogenetica (brine shrimp) ingestion is seen 12 0.57 and 1.1 0.16 particles/mL the shrimp survival rate for 14 days is 95 % and fluorescent MPs were visualized in shrimp it causes a response in epithelial cells in the intestine, effects in reproduction, adverse effects on outcome pathway (Wang et al., 2019). In this review, we demonstrate the presence, nature, types, and distribution of MPs in marine environments. How MPs enter inside the shrimp, size range, cause, and effects were observed. Some MPs will trophic transfer from lower organisms to higher organisms through feeding behavior. Humans consume more seafood if this shrimp was affected by MPs there would be more impact on health and preventive measures were discussed in this study.

2. Microplastics presence in marine ecosystem

90.2 % of global plastic production is fossil-based, with the remaining 8.3 % and 1.5 % coming from recycled and bio-based plastics, respectively (Khan et al., 2022). Plastic waste ends up in water bodies, it undergoes aging and degradation of MPs and it may cause colour changes, chemical behaviour changes, morphological changes, density, and size changes (Guo and Wang, 2019). The oxidation and chain scission of plastic polymers leads to degradation, which has the tendency to change the chemical composition, all properties, texture, and appearance of plastics (Zhang et al., 2021). These degradation processes cause weight loss, gas release into the environment, plastic fragmentation, and the formation of MPs (Tosin et al., 2012). Photo oxidative degradation is the process of decomposing plastics using light to produce esters, aldehydes, and propyl groups. This results in molecular weight changes and the formation of MPs (Wang et al., 2021b). Thermal degradation occurs as a result of thermal light and ultraviolet rays. The presence of ozone gas in the environment causes polymer ageing and fragmentation (Liao and Chen, 2021). Mechano-chemical degradation occurs when the degradation of plastics into small pieces is caused by strong ultrasonic and mechanical stress, which leads to the breakdown of the molecular chain and causes a chemical reaction (da Costa et al., 2017). The formation of hydrocarbons in waste polymers is catalytic degradation, and the most common biodegradation occurs when a microbial community forms on the surface of plastics and degrades the plastics into small fragments, which is also a cause of MP formation in marine environment (Manzoor et al., 2022).MPs have a proclivity to accumulate pollutants such as metal absorption and persistent organic pollutants (POPs) which cause drastically with the same magnitude as reported in all marine environments (Wang et al., 2021a). If these MPs are ingested by marine species, they may be transferred to other organisms via the food chain and have negative consequences such as reduced food intake, growth retraction (Fig. 1) (Li et al.; Galgani et al., 2013).

According to Lee et al, *copepoda* offspring and adults have a significant impact on MPs, causing toxicity to organisms (Lee et al., 2013). MPs exposed for a short time in European seagrass cause reduced swimming velocity and resistance time; Barboza et al discovered enzymatic imbalance and oxidative stress in *Dicentrarchus Labrax* (European seagrass) (Barboza et al., 2018). Over 95 % of MPs found in scats less than 5 mm in New England coastal areas has been identified in some fishes such as *Pesudopleuronectes Americanus* and *Myoxocephalus Irenaeus* (Carpenter et al., 1972). Microplastics in the gut of zebrafish, which contain fibers, fragments, and beads and cause toxicity in the gut, mucosal damage, and organism inflammation (Qiao et al., 2019).

3. Abundance and effects of microplastics in shrimp

Scientific reports discussing the abundance of MPs are very limited. Through the literature survey, we have come across 16 research articles elaborating on the same (Table 1). From these articles, we came to know that MPs contamination in shrimp is mostly seen in the stomach,

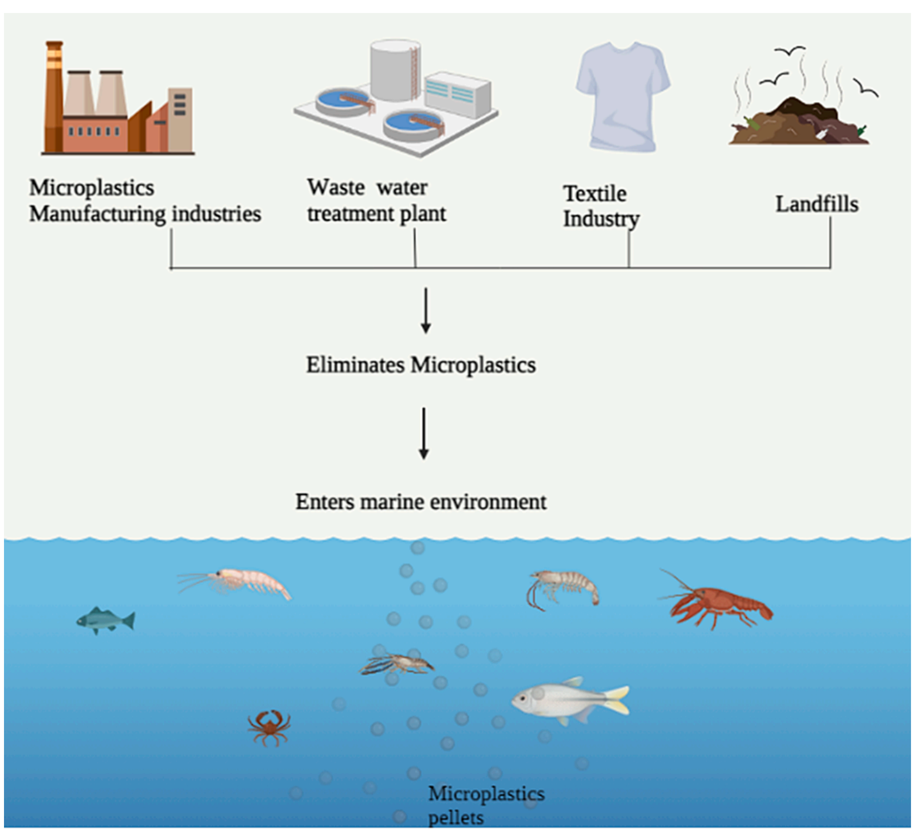

Fig. 1. Abundance and source of MP that enters the marine environment. Further enters the marine organisms.

Table 1
Abundance of Microplastics in various scientific reports:

S. No	Location	Source	No. of Shrimp Analyzed	Type of Microplastics	No. of Microplastics	Chemical Composition	Author
1	Guangdong Province, Zhuhai city	Pond water	*Litopenaeus vannamei* (54 individuals)	Fibers (92.66 %) Fragment (5.84 %)Films (1.50 %)	14.08 ± 5.70 items/g	Cellulose	(Yan et al. 2021)
2	Cochin, Kerala	Coastal water	*Fenneropenaeus indicus* (330 individuals)	Fibers (83 %) Fragment (15 %)Sheets (2 %)	0.39 ± 0.6 MP/shrimp	Polyester Polyamide Polyethylene Polypropylene	(Daniel, Ashraf, and Thomas 2020)
3	Khlong U-Taphao, Songkhla Province	–	*Metapenaeus moyebi* *Macrobrachium rosenbergii* (34 individuals)	Fiber (48.61 %) Fragment (51.39 %) &Fiber (53.93 %) Fragment (46.07 %)	14.76 ± 1.98	Rayon Polypropylene Polyethylene Terephthalate Polyester	(Jitkaew et al., 2023)
4	Khwae Noi, Thailand	Freshwater	*Macrobrachuim lanchesteri* (300 individuals)	Filamentous	0.46 ± 1.64	Polydimethylsiloxane Polyamide Polyester Polymethyl Methacrylate	(Tongnunui et al. n.d.)
5	Bahia Blanca, Atlantic ocean	Estuary	*Pleoticus muelleri* (40 individuals)	Fiber	3.40–3.87 items g^{-1}	Polyethylene Polypropylene Cellulose	(Fernández Severini et al. 2020)
6	Korea	Super market	*Litopenaeus vannamei* (150 individuals)	–	3.8 MPs/10 g	Polyethylene Polypropylene Polyethylene Terephthalate Polystyrene Polyvinyl Chloride	(Yoon et al. 2022)
7	Thailand	Cultured Pond	*Macrobrachium rosenbergii* (300 individuals) *Litopenaeus vannamei* (150 individuals)	Fiber Sphere Film Fragment	1166	Polyethylene Poly vinyl alcohol Polycaprolactone Acrylonitrile-butadiene-styrene	(Reunura and Prommi, 2022)
8	Northern central Victoria	Fresh water	*Paratya australiensis* (132 individuals)	Fiber Fragment	2.4 ± 3.1 items/g	Rayon Polyester	(Nan et al. 2020)
9	South North Sea and Channel area	Sea water	*Crangon crangon, Linnaeus* (165 individuals)	Fiber	0.68 ± 0.55 MPs/g	–	(Devriese et al. 2015)
10	Northern Bay of Bengal	Offshore water	*Metapenaus monocerous* (100 individuals) & *Penaeus monodon* (50 individuals)	Fiber Particle Fragment	3.87 ± 1.05 items/g & 3.40 ± 1.23 items/g	Polyamide-6 Rayon	(Hossain et al. 2020)
11	Coastal south Carolina	Beach & Estuary	*Litopenaeus setiferus* (75 individuals)	Fiber	1.49 ± 1.76 per shrimp	–	(Funck 2022)
12	Arabian Sea	Coastal water	*Metapenaus monoceros* (60 individuals) *Parapenaeopsis stylifera* (50 individuals) *Penaeus indicus* (70 individuals)	Fiber (42.21 %) Fragment Pellets Beads Films	70.32 ± 34.67 MPs/g	Polyethylene Polypropylene Nylon Polyester Polyethylene Terephthalate	(Gurjar et al. 2021)
13	Northwest Persian Gulf	Sea water	*Metapenaeus affinis* (75 individuals)	Fiber (78.6 %) Film (16.1 %)	1.02 items/g	Polyethylene Terephthalate Polypropylene Polystyrene	(Keshavarzifard, Vazirzadeh,and Sharifinia, 2021)
14	Songkhla lake, Thailand	Lake water	*Parapenaepsis hardwickii* (18 individuals) & *Metapenaeus brevicornis* (18 individuals)	Fiber	4.11 ± 1.12 3.78 ± 1.12	Polyester Nylon Poly vinyl alcohol Polyethylene Paint	(Pradit et al., 2021)
15	Balearic Basin, Mediterranean Sea	Deep water	*Aristeus antennatus* (148 individuals)	Fiber	70.4 ± 36.3 (distance 1) 34.1 ± 16.8 (distance 2) 36.2 ± 10.9 (distance 3)	Polyethylene Terephthalate Nylon Rayon	(Carreras-Colom et al. 2018) (Carreras-Colom et al. 2018)

intestines, gills, head, and tissues of shrimp (Jitkaew et al., 2023). As of now, the shrimp species such as *Litopenaeus vannamei, Fenneropenaeus indicus, Metapenaeus moyebi, Macrobrachium rosenbergii, Macrobrachuim lanchesteri, Pleoticus muelleri, Paratya australiensis, Crangon crangon, Linnaeus, Metapenaus monocerous, Penaeus monodon, Litopenaeus setiferus, Parapenaeopsis stylifera, Penaeus indicus, Metapenaeus affinis, Parapenaepsis hardwickii, Metapenaeus brevicornis and Aristeus antennatus* are exposed to MPs. Ponds, freshwater, seawater, estuaries, and local markets are the common sample sources in which these exposures are reported. To avoid external plastic contamination, these samples are transferred to a lab in hygienic conditions; the average length, weight, and height of the sample are recorded in scientific reports (Yoon et al., 2022). Fibers are the most abundant in Reunura and prommi et al study, followed by fragments, films, sheets, filamentous, spheres, particles, beads, and pellets with sizes ranging from 70 μm to 4000 μm (Reunura and Prommi at al. 2022). The maximum MPs abundance is seen in the Arabian Sea at 70.32 ± 34.67 MPs/g and the least MPs abundance is seen at 0.46 ± 1.64. Fourier Transform Infrared spectroscope is used to determine the type of MPs present in samples (Keshavarzifard et al., 2021). PE is the most common MPs found in shrimp, followed by Polyester, PET, PP, Cellulose, and others (Pradit et al., 2021).

To understand the effects of MPs on shrimps it is exposed to different diameters of spherical fluorescent polystyrene (Fig. 2). Preparation of MPs before exposure is done by adding ultrapure water in particles centrifuged using ultracentrifuge and further washed with tween 80, ethyl alcohol kept in a sonicator (Nakanishi, 2021). Polystyrene has an effect on swimming and feeding behavior, such as inhibiting growth due to physical blockage of MPs in the GIT, resulting in less absorption of food and a lack of nutrition, the presence of shrimp inside the stomach, and a decrease in swimming activity in Neomysis japonica (Mysid shrimp) (Wang et al., 2020). The presence of polystyrene MPs in shrimp and oyster disrupts reproduction and affects offspring development; if the shrimp was exposed to MPs for a long time, causes chronic effects such as growth effects, difficulty in reproduction, and effects on fitness (Gray and Weinstein, 2017). The presence of MPs in marine organisms has resulted in the formation of reactive oxygen species, which, combined with oxidative stress, reduces antioxidant enzymes and leads to chronic exposure to weathered MPs (Timilsina et al., 2023). Shrimp, like humans and other fish, lack an adaptive immune response. MPs have the potential to accumulate stress in organisms, which could lead to their death (Leads et al., 2019).

4. Tropic transfer

Marine carnivorous often consume the lower organisms like phytoplankton, zooplankton, and meroplankton as opposed to floating plastic particles, the amount of MPs in the gut of lower organisms determines the number of MPs in higher organisms (Egbeocha et al., 2018). The small-size MPs are more bioavailable in marine organisms and they are accidentally ingested by marine organisms and also affect food webs, concentration, and size in natural conditions (Wright et al., 2013). Secondary MPs are more harmful than primary MPs. The marine organisms have developed organs for prey detection, and the presence of a large number of plastic polymers may be unfavourable conditions

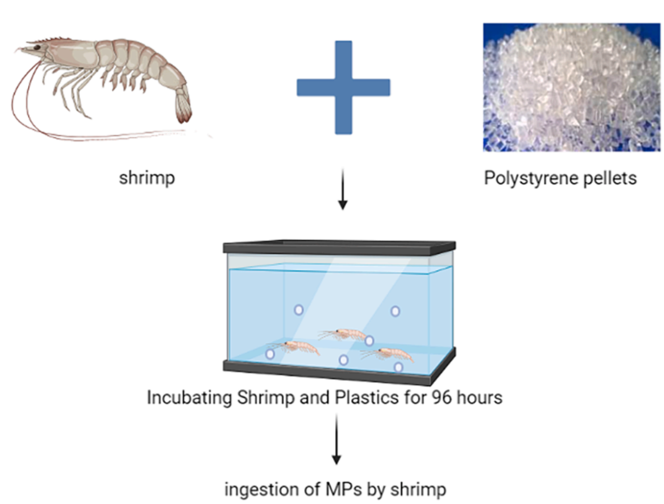

Fig. 2. Experimental observation of ingestion of MP by shrimp to analyze the effects on organisms in the laboratory scale.

(Setälä et al., 2018). MPs are typically retained in the body of organisms for several weeks to months after ingestion. Tropic transfer occurs when predators consume organisms that have consumed MPs (Bour et al., 2020). MPs are easily ingested by fish, either directly or indirectly, and adhere to suspended seaweed on the surface, which is then consumed by grazing gastropods (Trestrail et al., 2020). Although the consumption of MPs is low in lower organisms such as phytoplanktons, when they transfer to higher organisms, the bioaccumulation of MPs increases, causing more toxic effects on the environment (Huang et al., 2021). Plastic debris in the digestive tract affects over 690 species and spreads to higher organisms (Carbery et al., 2018). Polystyrene is fed through the food chain found in lion scats, from algae to plankton to golden fish, causing weight loss and an increase in cholesterol levels in the blood, muscle, and liver (Wright, 2015). The mode of feeding determines the presence of MPs in invertebrates, and in crab analysis, MPs are found in the stomach, gills, ovary, and pancreas before being transferred to the food web (Franzellitti et al., 2019). Photosynthesis has an impact on the food web as well, 41 % of MPs are retained in marine species, with the majority of MPs found in haemolymph rather than tissues. This transfer could increase the number of MPs through bioaccumulation and biomagnification for both prey and predators (Farrell and Nelson, 2013). Polystyrene particles are found in *Daphnia Magna* and *Pimephales promelas*, and these MPs are transferred to other organs under marine environmental conditions (Elizalde-Velázquez et al., 2020). MPs were first identified in spider crabs, and trophic transfer also occurred; ingested MPs are seen in the stomach and transferred to *p.platessa* as plankton feeders and ammodytes as piscivorous organisms. Plastic debris was found in greater abundance in marine species and loads to higher level organisms in some organisms. MPs are egested and not retained in the gut for a longer period, increasing feeding rate, whereas contaminated prey is consumed in a short period (Welden et al., 2018). The function of larvae was reproduced and contain MPs in the species these MPs are ingested in zooplankton affecting the swimming level and loss of weight in species affecting social behaviour and liver metabolism (Al-Thawadi, 2020). MPs pollutants in wild fishes are seen as indirect ingestion of MPs, which affects the digestive system and is transferred to marine top predators and expelled by faeces after some time in biotic and abiotic conditions. These MPs are then transferred to humans, where they cause a variety of effects (Nelms et al., 2018).

5. Microplastic toxicity to living organisms

The MPs which enter the marine environment due to many factors, MPs which are large in size has a great absorption property for toxic substances such as heavy metals and persistent organic pollutants like bisphenol A, zinc, lead, tributyltin it leads to potential toxicity to living organisms (Verla et al., 2019). Additives such as plasticizers, pigments, and dyes, most commonly phthalates, will leach from the MPs over time and remain in the environment.(Gasperi et al., 2018). This MPs causes toxicity in shrimp which leads to improper feeding behavior and starvation, transparent carapace, affects digestion, excretion and further suppresses growth (Leads et al., 2019). In Artemia parthenogenetica, this toxin causes epithelial cell damage, inflammation in the intestine, changes in swimming behaviour due to a lack of energy, lesions in tissues such as the gills, Gastrointesinal Tract, and liver, which affect metabolism and inhibit growth.(Wang et al., 2017; Li et al., 2021). Inhaling MPs fibres in humans causes inflammation in the respiratory system and lesions, and some amount of fibrous MPs has been visualised in human lungs, while removing tumours in the lungs has a higher potential to cause cancer.(Elizalde-Velázquez and Gómez-Oliván, 2021). Excessive amounts of MP particles in humans can cause inflammation and MP translocation.(Blackburn and Green 2021). Metals such as aluminium (Al), antimony (Sb), barium (Ba), arsenic (As), silver (Ag), strontium, and other heavy metals have the potential to mimic the activity of estrogens and have a high affinity of binding with estrogen receptors, which leads to breast cancer. These metals activate the receptor.(Enyoh et al., 2020). Cadmium has the potential for DNA methylation and causes cell apoptosis, resulting in oxidative stress. (Campanale et al., 2020b). Bacteria such as staphylococcus and parabacteroid interact with MP. PE can cause inflammation in the intestine, as demonstrated in a mouse model fed 600 μg.(Li et al., 2020). It begins with acute inflammation and progresses to chronic inflammation, resulting in chronic obstructive pulmonary disease. FGF8 also causes inflammation.(Sun et al., 2021; Pulvirenti et al., 2022). When human gingival fibroblasts were incubated with MPs isolated from the Adriatic Sea, inflammatory pathways NFkb and MyD88 were activated in cells, causing inflammation (Diomede et al. 2022).

6. Impact on human health

Humans consume plastic debris through the consumption of marine food products. MPs have contaminated the majority of the seafood. MPs account for approximately 28 % of the MPs found in the guts of marine organisms, and these MPs particles are transferred to humans (Issac and Kandasubramanian, 2021). MPs particles such as polyvinyl chloride and polystyrene are translocated from the gut to the lymph and circulatory systems, and some small particles are transferred to cells, blood, and the placenta, where they damage cells, cause oxidative stress, and have other negative effects on human health (Sana et al., 2020). The exposure of MPs in humans through inhalation because MPs is tiny it can move easily through the air and has a higher chance of entering humans through respiration, ingestion through consumption of seafood, and dermal contact with environmental plastics may adhere to the skin surface (Pironti et al., 2021). Exposure of MPs by ingestion reaches the gastrointestinal tract causes inflammation, inhibits viable cells, and affects gene expression (Prata et al., 2020). Some of the fibres are being measured in human lungs. Biopsies cause cancer, and chronic inflammation, and MPs in the circulatory system cause malnutrition. Blood cell cytotoxicity causes red blood cell aggregation and risk in neoplastic cells. MPs have an impact on humans through ingestion, inhalation, and dermal contact (Pilar and Gascón, 2020). Humans consume 212 MPs particles per year in 3 major cities South Korea such as Seoul, Gwangju and Busan, while 72.1 g day^{-1} and 1800 particles are consumed per year in Belgium, Europe. Pinocytosis and the phagocytic process both involve absorption (De-la-Torre, 2020). MPs stimulate cytokine production, and additives such as BPA have endocrine effects; polycarbonate obesity affects the hormone levels of fat tissues and activates lipoprotein lipase (Bhuyan 2022a). Microfold-cells (immune cells) mediated endocytosis translocated and internalized Gastrointestinal Tract MPs to the placenta, and MP-contaminated placenta has more adverse effects such as preeclampsia and inhibits foetal growth, which can lead to a dangerous pregnancy and toxic contaminant release (Ragusa et al., 2021). MPs is seen in human blood and lung tissue with an average of 29.28 ± 34.88 MPs/g with the polymers like irregular shape, alkyd resin, polyvinyl acetate, nylon-ethylene–vinyl-acetate, nylon-EVA, tie layer (Rotchell et al., 2023). MPs is present in breast milk in the form of fragments and floccules shape in sizes 1–50 μm and 300 μm respectively. Micro-Raman spectroscopy shows the abundance of nylon 6, PE, and PET (Liu et al., 2023).

MPs can cause an autoimmune disorder by stimulating immune cells, which will begin with prolonged damage to cells (Yang et al., 2022). Prolonged presence of MPs causes inflammation and induces DNA damage, which causes cancer associated with malignancies (Bhuyan 2022b). Ragusa et al. demonstrated the presence of MPs in the placenta, which has a high potential risk of inducing breast cancer. It also causes a decrease in the activity of the ovarian response. Bisphenol A is used in in vivo fertilisation, which results in early reproductive outcomes (Ragusa et al., 2021). If MPs are ingested by humans, they enter the gastrointestinal tract, causing toxicity and inflammation due to their prolonged presence. They then enter the circulatory system, where they accumulate effects based on the load of MPs. Finally, they are excreted as stool. The most common MPs found in stool are PE and PP (Campanale et al., 2020a). Inhalation The presence of MPs in dust causes respiratory, cytotoxic, and inflammatory effects; these plastics enter the lungs, and small plastics penetrate the bloodstream, causing inflammation (Ghosh et al., 2023).

7. Preventive measures

To prevent MPs pollution, governments in India and the United States have implemented policies such as banning of disposal plastic bags in 12 states such as California, Colorado,Connecticut, Delaware, Hawaii, Maine, New Jersey, New York, Oregon, Rhode island, Vermont and Washington and encouraging the recycling programs of plastics such as containers and bags are very effective. It provides some benefit, but there is more depth; microbeads are non-biodegradable plastics that are prohibited because they cause more harm than good, and 37 % of MPs debris is found in marine environments (Stoll et al., 2020). Even though Waste Water Treatment Plants (WWTPs) can remove 98.41 % of MPs from wastewater and only 0.25 MPs/L remain in the final effluent, significant volumes of MPs continue to infiltrate rivers due to the massive volume of effluent discharged from WWTPs. The government should take preventive measures, and wastewater treatment should include 100 % debris removal (Ali et al., 2021). The textile industry should improve textile manufacturing and reduce microfiber elimination into the environment (Prata, 2018). We should focus on the 4Rs: reduce, reuse, recycle, and recover. Education and awareness about the effects of MPs should be created (Patil et al., 2021). Single-use plastics contribute to pollution in the environment; therefore, single-use plastics should be avoided at all costs and replaced with biodegradable plastics (Picó and Barceló 2019). we should focus on the production of more oxo-degradable plastic products because they can remove the small plastics by fragmenting them in last stage of plastics (Thomas et al., 2015).

8. Future perspective

MPs will rise further in the future. If this trend continues, we should reduce plastic production and begin using biodegradable product that can mimic plastic without harming nature or humans. MPs will eliminate more chemicals in the marine environment; these should be removed using advanced techniques, and water bodies should be cleaned regularly. People should not litter the environment it endangers marine life. Currently, most scientific reports only mention the quantification of MPs, with few studies reporting on There have been fewer studies on the toxicity and effects of MPs, as well as its bioaccumulation and bioavailability within cells. Still, in some countries, waste management is inadequate due to a lack of awareness about the importance of reducing, reusing, and recycling plastic products. We should reduce the use of plastics. There should be a proper waste disposal protocol in place, and standardized procedures for treating primary and secondary MPs should be followed in WWTPs.

9. Conclusion

MPs are plastics that are less than 5 mm in diameter but have a greater impact on the environment and living beings. These plastics take 450 years to degrade and cause damage to both the marine and terrestrial environments. These plastics are classified into two types: primary MPs and secondary MPs. Primary MPs are man-made plastics used in manufacturing, while secondary MPs are fragments of primary MPs. These MPs are more harmful to prawns because they affect growth, cause oxidative stress, and cause changes in swimming behaviour. Almost all shrimp have been found to have MPs in their gills, GIT, and muscles. Polyethylene (PE) and polyethylene Terephthalate (PET) are the most common MPs that affect and are present in the marine environment; microfibers are abundant in comparison to other plastics such as fragments, films, pellets, and so on. These MPs are mostly eliminated from aircraft, textile industries, cosmetics, toothpaste, and single-use plastics in the environment, where they will fragment due to climatic changes, sun exposure, ultraviolet rays, and other factors, causing more effects on the marine environment. These MPs will float in the ocean, where marine organisms will assume it for food and consume it, clogging the GIT and preventing further food consumption, causing growth retardation and affecting reproduction. MPs is found in the gills, GIT, and muscles of 85 % of marine organisms. These ingested MPs will translocate into other organs and then trophic transfer from lower organisms to higher organisms, eventually reaching humans. MPs is most commonly transported via ingestion, inhalation, and dermal contact. Because MPs contamination is everywhere, we must reduce our use of plastics and find the best alternative for everyday use. Now that MPs has been detected in breast milk, we must manage waste properly, recycle all possible plastics, and stop using plastics to achieve zero plastic pollution in the environment.

The mechanisms by which toxic chemicals absorb and desorb from MPs has not been fully understood, but through possible factors such as hydrophobic interaction, different pH, weathering of plastics and composition of MPs. To conclude MP, pose significant risks to both marine and terrestrial environment, to address this issues more effectively research on MPs should be more prioritised and understanding the environmental health effects of MP pollution is most needed. By focusing on research and implementing comprehensive strategies, we can work towards a more environmentally friendly earth and better healthy lifestyle.

CRediT authorship contribution statement

Amrutha Vellore Mohan: Writing - original draft. **Sudhakaran Raja:** Writing - Review & Editing.

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