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Microplastics: A Looming Threat to Human Life and Ecosystem

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Abstract

Microplastics, the minute plastic particles measuring less than 5 millimetres in size, have emerged as a silent yet pervasive threat to human life and the entire environment. This article delves into the multifaceted dangers posed by microplastics, investigating their sources, pathways of exposure, and potential health and environmental implications. Microplastics have a multitude of possible adverse health consequences, such as oxidative stress, inflammation, and the secretion of toxic chemicals. Moreover, these minute particles can serve as vectors for the transport of pathogens and contaminants, exacerbating health concerns. The persistence and bioaccumulation of microplastics further exacerbate their potential adverse effects on human health. In the face of this mounting peril, this article aims to raise awareness and advocate for a comprehensive approach to tackle the microplastics issue, thereby safeguarding human health and preserving the environment for future generations.

Keywords: bioaccumulation, degradation, environmental contaminants, human health, toxicity

1. Introduction

The word plastic comes from the Greek (*plastikos*), which means "capable of being shaped or moulded." In essence, plastics are composed of monomers, which are synthetic or semi-synthetic organic (carbon-containing) chemicals mostly produced from natural gas and crude oil. Plastics are categorized according to their size by the Group of Experts on the Scientific Aspects of Marine Environmental Protection. According to their size, plastics present in the environment may be divided into five classes: nanoplastics (<1 μm), microplastics (≥1 μm to <5 mm), mesoplastics (≥5 mm to 5 cm), macroplastics (>5 cm to 50 cm), and megaplastics (>50 cm).

Due to their portability and light weight, plastic items have permeated every aspect of the economy and have become a necessary component of all human endeavours. The primary source of the world's total plastic waste is the packaging industry, which is followed by the textiles, consumer goods, and other industries. A total of 10 million plastic tons are dumped into the ocean annually. It is estimated that 1.5 million tons of primary microplastics are released into water each year, giving some perspective on the scope of this water pollution. They are tiny plastic fragments sourced from a broad range of items, including face wash, soap, fabrics, and waste plastics. As is well known, these tiny particles have detrimental effects on ecosystems and come from a variety of sources, including the breakdown and fragmentation of plastics. Microplastics can injure people physically by obstructing internal passageways and damaging tissue, as well as chemically by transporting poisons and pollutants.

Endocrine disruptors like microplastics can change the hormonal signalling pathways required for the healthy operation of reproductive systems. Due to their abrasive nature, they can physically harm reproductive structures including the ovaries and testicles. When microplastics penetrate our bodies, they cause inflammation, which can result in a number of health problems. They may also release harmful substances into the body, which may result in a variety of health difficulties, including as cancer (Kumar *et al*., 2022), difficulty with reproduction, and developmental abnormalities. The development of antibiotic resistance has also been linked to microplastics (Chatterjee and Sharma, 2019).

2. Sources of Microplastics

Marine ecologist Richard Thompson, of Plymouth University, United Kingdom, coined the term “microplastics” in 2004, on discovering the tiny particles on British beaches. “Microplastics are any synthetic solid particle or polymeric matrix, with regular or irregular shape and size ranging from 1 µm to 5 mm, of either primary or secondary manufacturing origin, which are insoluble in water” (Frias and Nash, 2019). Timeline events of microplastic’s discovery has been shown in Figure 1.

The production of microplastics comes from both primary and secondary sources. The primary sources of microplastics are those that consciously produced them for consumer and industrial use, such as exfoliants in cleansers, cosmetics, drug delivery particles in pharmaceuticals, and industrial air blasting. Microplastics are abundant in the water and may be found from the top to the seabed. Additionally, freshwater sources including rivers and lakes have been reported to contain microplastics, which can build up in the sediment and in the tissues of aquatic life. Microplastics are also present in soil, where they can be released

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into the environment when plastic waste films and other agricultural products made of plastic are applied (Khalid *et al*., 2023).

3. Degradation mechanism

Plastics can degrade in several ways, resulting in microplastics and nanoplastics, that can be categorized as either biodegradation and non-biodegradation processes. Thermal degradation, hydrolysis, photodegradation, physical degradation, and thermo-oxidative degradation are instances of non-biodegradation processes (Turner *et al*., 2020). Microorganisms can create extracellular enzymes which can dissolve chemical bonds and polymer chains, releasing CO_2, H_2O, CH_4, and N_2 (Yuan *et al*., 2020). Numerous enzymes from bacteria, fungi, algae and actinomycetes have been found to breakdown numerous types of plastics (Urbanek *et al*., 2020).

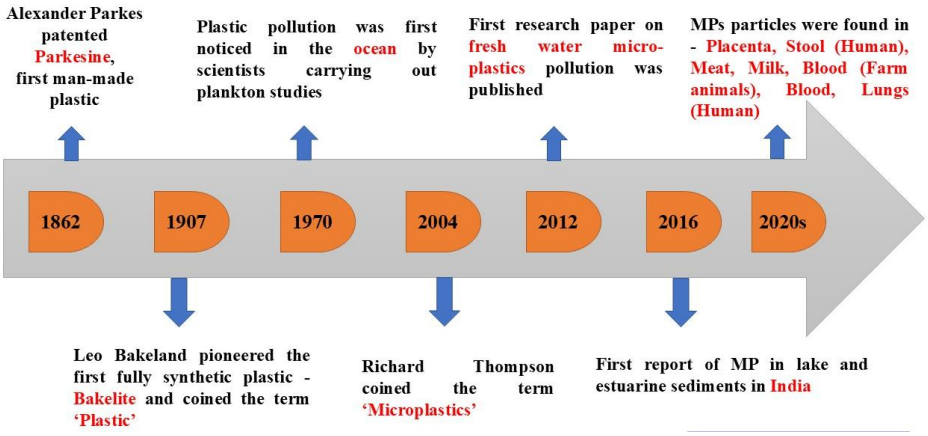

Figure 1. Timeline of report from plastics to microplastics

4. Impacts of Microplastics on the Ecosystem

Microplastics have an enormous effect on the tiniest invertebrates to the largest marine animals in many habitats and marine life. Marine creatures confuse microplastics for food, which causes them to consume them and accumulate them in their bodies. Furthermore, eating microplastics puts marine creatures at risk of malnutrition as they fill their bellies with nothing but garbage. Microplastics have also been shown to alter the physiology and behaviour of marine species, making them less able to swim and more susceptible for predators (Li *et al*., 2022; Mkuye *et al*., 2022). Sources and fate of microplastics have been shown in Figure 2.

By decreasing water retention and influencing nutrient cycle, microplastics in soil have been shown to modify its characteristics (Lozano *et al*., 2021). Microplastics can cause detrimental effect on aquatic creature health and disturb the food chain in freshwater habitats. Unfortunately, the existence of microplastics in marine habitats has a substantial negative economic impact on sectors like tourism and fish farming. Fish and shellfish lose quality and

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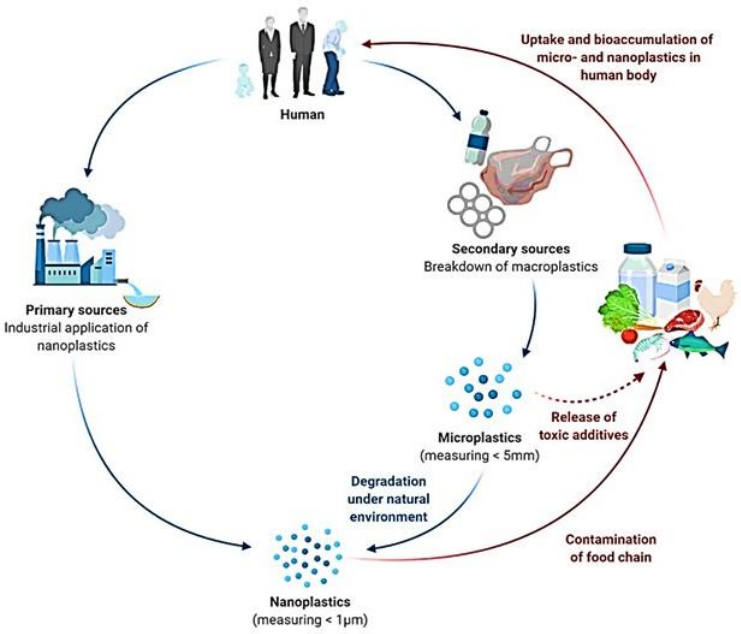

Figure 2. Source and fate of microplastics

value on the market because of the microplastics building up in their tissues (Bhuyan, 2022; Daniel *et al*., 2021).

5. Impacts of Microplastics on Human Health

Ingestion, inhalation and dermal exposure are the three main ways that microplastics enter the human body. The most frequent route for human to be exposed to microplastics among them is by ingestion (Campanale *et al*., 2020). However, using personal care products that include microbeads, such as body washes and face cleansers, might result in dermal exposure to microplastics (Wang *et al*., 2022).

Numerous studies demonstrate that microplastics may cause genotoxicity in human cells (Roursgaard *et al*., 2022), cellular damage, and inflammation. Thus, it's critical to limit exposure to microplastics and their discharge into the environment to safeguard ecosystems and human health. Skin irritation and inflammation have been associated with dermal exposure to microplastics, which may also lead to additional health issues such reproductive toxicity (Dubey *et al*., 2022) and endocrine disruption (Campanale *et al*., 2020).

6. Current Initiatives to Resolve the Problem

The aim of various national and international programs and regulations is to lessen the pollution caused by microplastics. Through its Clean Seas initiative, which aims to eliminate major sources of marine plastic and microplastic pollution, the United Nations has taken action to combat microplastic contamination on a global scale. The European Union has

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imposed a ban on the use of microplastics in personal hygiene products, including face wash and toothbrush, across Europe (Guzik *et al*., 2023).

A number of private sector initiatives are also in place to lessen the pollution caused by microplastics, in addition to these regulatory measures. To successfully inhibit pollution, addressing the issue of microplastic pollution offers a number of obstacles that must be solved. A multimodal approach is necessary to address the complex problem of microplastic contamination. It requires cooperation from a variety of stakeholders, such as governments, companies, and private citizens, as well as adjustments to patterns of consumption, production, and behaviour. A more thorough and well-coordinated solution to the worldwide problem of microplastic pollution can be made possible through international alliances and partnerships that promote the sharing of knowledge and resources (Lusher *et al*., 2021).

7. Conclusions

Microplastics represent a significant risk to both human health and the ecology since they come from sources like personal care and cosmetics and may be found in a variety of settings, including the ocean, freshwater bodies, soil, and even the air. Microplastics have important economic effects as well; the presence of microplastics in our surrounding ecosystem has an impact on sectors like tourism and fisheries. A comprehensive strategy that includes lowering plastic usage, enhancing trash management, creating innovative removal technologies, increasing public awareness, and enacting strict restrictions is needed to properly address this serious threat. Further investigation is also necessary to assess the efficacy of mitigation techniques and get a deeper understanding of the various consequences of microplastics.

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