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Microplastics: Major Contaminant in Water: A Global Environmental Concern

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Abstract

One of the most alarming environmental threats in recent years is microplastic. These miniscule particles of plastic, which originate from larger plastic products that are produced whether intentionally or non intentionally, are present everywhere in the environment. One of the most concerning sites where microplastics have been found in large quantities are water bodies. Rivers, lakes, ponds, oceans, and even drinking water in packed bottles are all adversely impacted by microplastic contamination, raising significant concerns for all human beings and animals, especially aquatic animals. Present paper is an attempt to showcase the state of art of microplastic contamination in water bodies. In addition of that,it also through light on the techniques (FTIR, Raman spectroscopy,Microscopy etc.) for identifying such contamination in water bodies.Further, it discusses the possible ways which should be undertaken by the government and also by the public to eradicate such nuisance and save mother earth.This work may open new ways by giving direction to scientific community engaged in making cleaner and safer water bodies drive.

Keywords: *Degradation, Microscopy, FTIR, Spectroscopy Microplastics, Contamination*

Introduction

Microplastics are very small plastic particles measuring less than 5 millimeters in size, they have emerged as one of the most prevalent, penetrating and concerning pollutants globally. [1]These microscopic fragments are the result of the breakdown of larger plastic items such as bottles, bags, and fishing nets, or can be manufactured for use in products such as cosmetics, cleaning agents, and clothing. As these particles are light in weight, durable, and resistant to natural degradation, they get accumulated in water bodies, further causing a serious threat to marine ecosystems including humans.

Sources of Microplastics in Water

Microplastics enter water bodies through a variety of routes. Some of the primary sources are as follows:

1. **Degradation of Larger Plastics**: When larger plastic items like plastic tanks, bottles, bags, and fishing nets break down due to exposure from sunlight, wind, and water, they fragment into smaller particles, contributing to microplastic pollution. This process, known as photodegradation or mechanical degradation, produces microplastics that can enter water bodies directly or are washed by rain water.[2]
2. **Synthetic Fabrics**: One of the most significant sources of microplastics in water is the shedding or degradation of fibers from synthetic fabrics during washing. Clothes made from materials like polyester, nylon, and acrylic release tiny fibers when washed, which then flow into wastewater bodies and ultimately end up leaving tiny plastic particles in rivers and oceans.[3]
3. **Cosmetics and Personal Care Products**: Many personal care products, such as facial scrubs, toothpaste, and shower gels, contain microbeads which are made from plastic. Despite efforts to ban such products in some countries, microbeads are still found in many products, ultimately contributing to water pollution.[4]
4. **Industrial Processes**: Certain industries that use plastic as a raw material or as part of their production process can unintentionally release microplastics into water bodies. This includes plastic manufacturing, construction, and the production of plastic pellets that can escape into the environment leading to environmental pollution.[5]
5. **Storm water Runoff**: Storm water runoff can carry plastics from roads, waste dumps, drainage system and other urban areas into nearby water bodies. This can include microplastics from plastic packaging, and other debris, which further contributes to water pollution.[6]

Methods for Identification and Estimation of Microplastics

Samples in the form of sediments and from various water sources such as lakes and rivers are collected.
Once the samples are collected, they can be analyzed for microplastics. Common analytical techniques include:

1. **Microscopy**: Techniques such as optical or electron microscopes are used to identify and count microplastics in a sample. This method requires particles to be separated, typically by density separation method.[7]
2. **Fourier Transform Infrared (FTIR) Spectroscopy**: FTIR is used to identify the chemical composition of the particles and confirm whether they are plastic or not.[8,9]
3. **Raman Spectroscopy**: Similar to FTIR, Raman spectroscopy can be used to identify microplastics by analyzing the molecular structure of the particles.[10]
4. **Pyrolysis-GC-MS**: This method involves heating the particles and further breaking them down, followed by gas chromatography-mass spectrometry to identify the plastic type.[11]

Environmental Impact of Microplastics

Microplastics are present everywhere in aquatic environments, and their presence has significant ecological consequences:

1. **Ingestion by Marine Life**: Aquatic animals, including fish, birds, and marine mammals, can mistake microplastics for food. Ingesting these particles can lead to physical harm, digestive issues, and can even lead to death in some cases. Moreover, microplastics can accumulate in the animal tissues, causing long-term health problems thus impacting the food chain. [12].
2. **Chemical Contaminants**: Microplastics can act as sponges for toxic chemicals present in the water, such as pesticides, insecticides, heavy metals, and persistent organic pollutants (POPs). These chemicals can adhere to the surface of microplastics, and when ingested by marine organisms, they can enter various levels of food chain, leading to the bioaccumulation of harmful toxins and substances in higher trophic levels, including humans.[13]
3. **Disruption of Ecosystems**: The accumulation of microplastics can disrupt ecosystems by altering the physical and chemical properties of aquatic plants and animals. For instance, microplastics can affect sedimentation patterns in water bodies, interfere with nutrient cycling, and alter the behavior of aquatic organisms [12].

Human Health Risks

Microplastics' impact on human health is still under evaluation, but concerns have been raised about the potential risks associated with the ingestion and inhalation of microplastics. Studies (Gambino et. al,2022; Gerretsen,2024,Brancaleone ,2024)have shown that microplastics are present in tap water, bottled water, seafood, and even air, suggesting that humans are exposed to these contaminants in numerous ways.[14-16]

1. **Ingestion via Drinking Water and Food**: The presence of microplastics in drinking water is a major concern. Studies have found microplastic particles in both tap and bottled water worldwide, with humans potentially ingesting thousands of microplastic particles annually. Coastal food, particularly shellfish, is another significant source of microplastic exposure due to the consumption of contaminated marine animals.[12]
2. **Toxicity of Associated Chemicals**: Microplastics often carry toxic substances, including heavy metals, insecticides, pesticides, and plastic additives. These chemicals may enter into the body upon ingestion or inhalation, leading to potential long-term health issues such as hormonal disruption, neurotoxicity, and even life threatening disease such as cancer [17].
3. **Potential for Airborne Exposure**: Microplastics are not limited to water bodies; they can also be found in the air. These tiny particles can be inhaled and may lead to respiratory problems or other pulmonary diseases, particularly for individuals in heavily polluted areas or urbanized areas [7].

Possible solution

Efforts to mitigate microplastic pollution in water bodies are still in the early stages, but several strategies are being explored and are under evaluation:

1. **Reducing Plastic Production and Usage**: The most effective way to combat microplastic pollution is to reduce plastic consumption and production. This includes promoting alternatives to plastic bags, improving waste management systems, and encouraging more sustainable materials in industries of fashion and packaging. Use of biodegradable material should be promoted.
2. **Improving Wastewater Treatment**: Upgrading wastewater treatment facilities to capture microplastics before they enter water systems is an essential step in water treatment. Technologies like filtration and specialized mesh screens can help trap microplastics, preventing them from being released into water bodies such as rivers, lakes, and oceans.
3. **Banning Microbeads in Personal Care Products**: Many countries have already banned or are in the process of phasing out the use of microbeads in cosmetics and personal care products. These bans must be extended to other consumer goods and companies must comply with environmental standards. This part is crucial in reducing microplastic pollution.

4. **Sensitization Program**: Making people aware about the sources and dangers of MPs contamination is very crucial to resolve such critical issues. Changing consumer behavior and encouraging policies aimed at protecting water resources such as rivers and lakes are indispensable for a better future.

5. **Research and Innovation**: Ongoing research is essential for better understanding the full scope of microplastic pollution and its impacts and adverse effects on various living organisms. Innovative solutions, such as biodegradable plastics, alternate degradable substances and more efficient cleanup technologies, are also being explored to address this growing concern [17].Invention of Robo fish could help in solving the MPs contamination issue as Robofish cling such contaminants to its surface. [1]

Conclusion

Microplastics are a significant and growing contaminant in water bodies all around the globe. They pose serious risks to ecosystems, marine life, food chain and human health. While addressing the issue is complex and requires coordinated efforts from all over the world, reducing plastic waste, improving wastewater treatment technology, and raising public awareness are critical steps in mitigating the effects of microplastic pollution. As research and technology evolve, it is hoped that effective solutions will emerge to safeguard our waters from the pervasive threat of microplastics that are endangering our lives.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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