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Marine Microplastics And Their Effects

Nikhilesh Sharan[1] & Dilpreet Kaur[2]
[1]Department of Zoology. Maharana Pratap Govt. P.G. college, Hardoi, Uttar Pradesh
[2]Department of Zoology. Maharana Pratap Govt. P.G. college, Hardoi, Uttar Pradesh

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Abstract

With the rise in population, waste management has become a significant challenge, and recent studies have pointed to the serious issue of marine litter. Human-produced waste is increasingly accumulating in marine environments, with large amounts of microplastics found in rivers, lakes, seas, and oceans. Research has shown that exposure to UV light and low temperatures helps break down regular plastics into smaller fragments, known as microplastics (MP), which are then carried into marine ecosystems through runoff. These microplastics are commonly made of materials like polyvinyl chloride (PVC), polyethylene terephthalate (PET), polystyrene (PS), and nylon. Due to ineffective waste management, the concentration of microplastics is rising at an alarming rate, impacting not only marine environments but also marine life. Studies have found that areas near urban centres have higher levels of microplastics, with aquatic animals in these regions showing significant accumulation of the particles in their tissues. Additionally, microplastics can attract other pollutants, such as dyes, heavy metals, and chemicals, acting as carriers for these substances within aquatic animals, which then enter the food chain.

Keywords:- Microplastics, Pollution, Sea food, Marine organisms etc

Introduction

Microplastics are tiny plastic particles, typically less than 5 millimeters in size, that result from the breakdown of larger plastic materials or are directly manufactured at small sizes (such as microbeads in cosmetics). They are categorized into two types:

1. **Primary Microplastics**: These are intentionally produced in small sizes, such as in cosmetic products, personal care items, and industrial applications.
2. **Secondary Microplastics**: These result from the degradation of larger plastic items due to exposure to environmental factors like UV radiation, water currents, and physical abrasion.

Effects of Microplastics on the Marine Environment

1. **Threat to Marine Life**:
    - **Ingestion by Marine Organisms**: Microplastics are often mistaken for food by marine animals such as fish, seabirds, turtles, and plankton. Ingesting these particles can cause physical blockages, internal injuries, and malnutrition. The particles may accumulate in their gastrointestinal systems, leading to reduced feeding efficiency and potential starvation.
    - **Toxicological Impacts**: Many microplastics contain toxic additives like flame retardants and plasticizers, or they can adsorb harmful chemicals like pesticides and heavy metals from the surrounding water. When ingested by marine organisms, these pollutants can lead to health issues such as oxidative stress, hormonal disruption, reduced fertility, and even death.
2. **Bioaccumulation and Biomagnification**:

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- Microplastics can accumulate in the tissues of smaller marine organisms and pass up the food chain through predation, leading to bioaccumulation in higher-trophic-level animals. This results in biomagnification, where top predators, including humans who consume seafood, end up with higher concentrations of microplastics and associated pollutants in their bodies.

3. **Habitat Disruption**:
   - Microplastics can settle on the ocean floor or mix with sediments, affecting benthic habitats. Organisms that live on or within sediments, such as shellfish and crustaceans, can be impacted by ingesting or coming into contact with microplastics, altering their natural behaviors, reproduction, and survival rates.
4. **Chemical Transporters**:
   - Microplastics act as carriers for other environmental pollutants. They can adsorb toxic chemicals from the water, such as persistent organic pollutants (POPs) and heavy metals. Once ingested by marine life, these toxic chemicals can accumulate in the tissues of organisms, further harming them and potentially transferring to higher trophic levels, including humans.
5. **Impact on Coral Reefs**:
   - Microplastics can physically damage coral reefs by smothering or lodging in coral structures, preventing their growth and making them more susceptible to disease. Coral reefs are critical ecosystems that support marine biodiversity, so their degradation can have far-reaching consequences for ocean health.
6. **Aesthetic and Economic Damage**:
   - Beaches and coastal areas polluted by microplastics not only degrade the aesthetic value of these environments but also impact tourism and fishing industries. Marine plastic pollution can reduce the attractiveness of natural environments and affect industries reliant on clean, productive waters.

In today's world, plastic has become an integral part of human life, with its applications being widespread in daily activities (Li et al., 2019). According to recent data, global plastic production reached approximately 367 million metric tons in 2020 (Tiseo, 2021 - Statista). Plastic is a synthetic material known for its unique properties, such as strength, durability, and lightness which is why it is widely used across industries like food, healthcare, and electrical products (Li et al., 2019). However, improper disposal of plastic has significantly contributed to the accumulation of this non-biodegradable material in water bodies such as seas, rivers, ponds, and in soil (Chae & An, 2018). Like other pollutants, including dyes, heavy metals, and organic contaminants, plastic has been identified as toxic to aquatic life (Umamaheshwari et al., 2020; Li et al., 2019).

A recent study by Sivagami et al. (2021) found microplastics in commonly used sea salts, highlighting the potential risks to human health. It is estimated that approximately 4.8–12.7 million tons of plastic are dumped into the oceans each year, and this amount continues to rise. Plastic debris in water bodies varies in size, shape, density, and chemical composition. Plastic particles ranging from 1 μM to 5 mm are classified as microplastics (Cole et al., 2011). Microplastics in aquatic environments are categorized into primary and secondary microplastics (Auta et al., 2017). Primary microplastics come from products like cosmetics, personal care items, children's products, and insect repellents, while secondary microplastics result from the breakdown of larger plastic materials through physical, biological, and chemical processes (Yuan et al., 2020).

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Synthetic materials such as polypropylene, polyethylene, polystyrene, polyvinyl chloride, and polyethylene terephthalate are the main microplastics found in marine waters by researchers worldwide (Dikareva & Simon, 2019). Due to their small size, microplastics pose a greater threat to aquatic organisms. Furthermore, contamination of these organisms provides an easy route for microplastics to enter the human body when these contaminated organisms are consumed as seafood.

How organisms react to the microplastics?

Many researchers have studied the negative consequences of microplastics on species, which can vary from interruption of biological functions to death. MPs poisoning is categorized as follows depending on the nature of MPs after intake:

1) build-up in the gastrointestinal tract, producing physical harm such as blockage and damage;

2) release as pseudofeces, disrupting organisms' energy transfer;

3) transfer inside the body, exposing inner organs and tissues to MPs.

MPs-caused detrimental effects on species were outlined to provide a solid research foundation for sustainable MPs toxicological investigations and to evaluate the potential for huge ecological disruption.

Impacts of Microplastics (MPs) on Fish

The effects of MPs on fish have been primarily studied in relation to specific physical or biological responses, with most research conducted in laboratory settings. Fish used in these exposure studies come from various environments, though the majority are marine species. When fish ingest MPs, these particles can accumulate in their gastrointestinal systems, leading to blockages in the digestive tract and reduced feeding due to loss of appetite (Lusher et al., 2013; Wright et al., 2013). MP consumption can also cause structural and functional changes in the digestive system, leading to nutritional and developmental problems in fish (Li et al., 2015). Numerous studies have shown that MPs pose a significant risk to fish, with many dying before reaching maturity due to MP ingestion. Most research has focused on Danio rerio, where common effects of MPs include oxidative stress, reduced mobility, gene expression disruption, and damage to reproductive organs (Zhao et al., 2014).

Microplastics in Humans

The presence of microplastics (MPs) in seafood presents a significant threat to human health, as seafood is a crucial part of the human diet. When MPs contaminate the intestinal system, there is a risk that they can spread to other parts of the body. Endocytosis and persorption are two common mechanisms through which MPs can enter the human body (Figure 4).

The toxicological effects of MPs may impair fish health and performance, which is concerning for humans who rely on fish as a staple food source, and this could also negatively impact fish populations and fishing industries. Further research is needed to fully understand these risks, particularly by considering realistic levels of MPs and pollutants in the environment (Neves et al., 2015).

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Conclusion- Plastic is a versatile and valuable material used in many everyday items. However, in the modern world, poor management, improper handling, and excessive use of plastics have led to widespread microplastic (MPs) pollution in aquatic environments, from surface waters to deep-sea sediments. Due to the abundance of MPs in these ecosystems, fish have easy access to them. Research increasingly shows that MPs are harmful to various fish species. After ingestion, MPs can accumulate in the gastrointestinal tract and spread to other tissues, causing numerous health issues. MPs can also transport toxic substances and harmful microorganisms to fish. When humans consume fish contaminated with MPs, they are exposed to these plastic particles, contributing to the occurrence of chronic diseases. Therefore, reducing MPs contamination is crucial. Effective waste management, improving the durability of plastic products, and raising awareness can significantly reduce plastic pollution, helping restore aquatic ecosystems. Overall, microplastics are a growing environmental threat with profound effects on marine ecosystems, biodiversity, and human health, highlighting the need for better waste management and plastic pollution mitigation strategies.

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