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MICROPLASTICS AND ECOTOXICITY: A REVIEW

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ABSTRACT

This review article mainly focuses on ecotoxicity of microplastics in aquatic microbes. According to current statistics, a whopping 5.25 trillion plastic pieces are being dumped in the ocean and ocean is the main zone where wastes are being dumped, if this continues further it is really necessary to look into how it is affecting the microorganisms present in that water body . With a population of 8 billion it's obvious that a lot of waste is generated but is dumping a large portion of it in water bodies a wise choice? This is the main focus of this article. Apart from this the types of plastics waste and their size ranges will be discussed along with details of the ecotoxicity with a few examples for an understanding of why the need of the hour is focusing on waste reduction in micro levels too.

INDEX Keywords: Microplastics, microorganisms , ecotoxicity

1.INTRODUCTION

Generally, the plastics dumped are referred to as microplastics(<5mm) but there are three more classes namely; mesoplastics (1–5 mm), microplastics (0.0001–1 mm), and nanoplastics (<0.1 µm).

The plastics dumped mostly are microplastics. The most common types are: polyethylene (PE), polypropylene (PP), polyvinyl-chloride (PVC), polystyrene (PS), and polyethylene-terephthalate (PET) (**Figure 1**) possessing specific physical, chemical, mechanical, optical, and electrical properties.

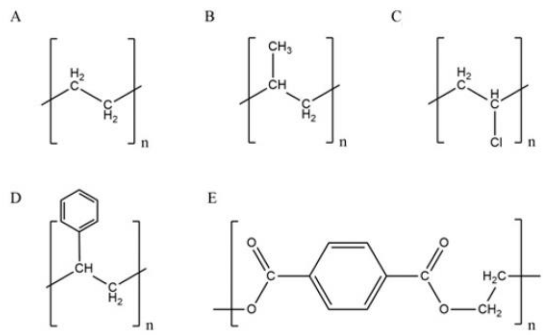

Figure 1. Chemical structures of: (**A**) polyethylene, (**B**) polypropylene, (**C**) polyvinyl-chloride, (**D**) polystyrene, and (**E**) polyethylene terephthalate.

Massive dna sequencing done recently introduced a new term called plastisphere [1].PE and PP are generally present on the surface seawater and it is something that is extensively studied.Photoautotrophic bacteria such as the cyanobacteria of the genera Phormidium and Rivularia dominate the sub-surface plastisphere communities [1],[2],[3].

The applications of polymers are determined by their properties, which can be enhanced through the addition of various accelerants, cross-linking additives, UV stabilizers, antidegradants, antioxidants, antiozonants, photosensitizers, surfactants, pigments, flame retardants, or plasticizers with biocidal additives. It is important to note that these properties are not limited to the additives.

2.MICROPLASTICS TYPES AND PROPERTIES

Plastics are composed of both crystalline and amorphous phases, which have a significant impact on their mechanical properties, including strength and elasticity. A lower amount of amorphous phase causes an increased density. As density increases, so does the elastic modulus, tensile strength, stiffness, and surface hardness. However, the impact strength is decreased.

PE is usually persistent in the environment due to its non-reactive C-C and C-H bonds, high molecular weight, hydrophobicity (allowing sorption on sediments or activated sludge)and lack of functional groups that can be identified by microbial enzymatic systems .

Hydrophobic surface and high molar mass of PP limits its biodegradation.. The insertion of hydrophilic groups onto the polymer surface via physical or chemical processes (e.g., degradation) is highly required to enable the attachment of microorganisms to such partially destructed polymer surface . Accordingly, microorganisms can use low-molecular-weight fragments (oligomers), dimers, or monomers as carbon and energy sources , providing biodegradation. However, small oligomers may also diffuse into the organism and get assimilated, providing adverse effects.

The PVC structure depicted in Figure 1 contains a heteroatom, chlorine, on every second C-atom of the polymer backbone.Due to its exceptional versatility,

PS, as depicted in Figure 1, has an amorphous structure with a phenyl ring linked on every second C-atom of the polymer backbone. It is commonly known in its expanded form as Styrofoam and is used for packaging, bowls, containers, rigid trays, lids, and tumblers. temperature of >100 °C, causing it to soften in boiling water. PS is also a poor oxygen and vapor barrier and is sensitive to UV irradiation, causing it to yellow.

PET, as depicted in Figure 1, is one of the main food packaging materials, along with PE. It is also commonly used in the textile industry, where it is used as fiber filling in insulated clothing, furniture, and pillows, fine filaments in artificial silk, and large-diameter filaments in carpet production. PET is a transparent and colorless semi-crystalline thermoplastic polyester that is strong and resistant to chemicals, with low vapor and gas permeability. It is a good alternative to glass and is used for the production of bottles/containers for beverages. However, PET is not preffered due to its high durability and low biodegradability.

3.SOURCES OF MICROPLASTICS IN THE ENVIRONMENT

Primary and secondary sources of MP in the environment are as follows:Textile (mixture of synthetic clothes accounts for 35% of the primary microplastics in the environment) ,Cosmetics (e.g. microbeads found in facial scrubs ~2%),Electronic equipment,Tire abrasion through driving (~28%), city dust (~24%), road making (~7%), marine coating (~3.7%) and plastic pellets (~0.3%) Primary MP enters the environment mainly via wastewater generated during the manufacturing or use phases [4],[5],[6].

Secondary sources include a breakdown of larger plastic fragments such as plastic bags, bottles, or fishing nets introduced in the environment; the breakdown is caused by UV radiation, physical abrasion, chemical oxidation, and possibly biodegradation[4], [5], [7].

4.CHARACTERIZATION METHODS FOR MICROPLASTICS IN THE ENVIRONMENT

Microplastics (MPs) in the environment vary not only in chemical composition but also in particle size, density and shape. These parameters play an important role in the fate, behavior and transport of MPs in the environment. MPs determination requires rapid and reliable analytical methods. These methods are typically divided into two phases: (i) the extraction and digestion of the organic fraction and (ii) the detection, quantification and characterization of the MPs. Different analytical methods have been used for the determination of MPs from various angles. However, each method is not complete, i.e. two or more methods must be used to gain full insight into MP properties, particularly when monitoring MP (bio) activity. In such cases, methods capable of detecting changes in the structure of the MPs (e.g. using spectroscopy or chromatography) are more useful than those that mainly provide insight into surface and morphological changes (i.e., using microscopy techniques).

4.1 MICROSCOPY BASED METHODS

Visual identification by binocular (polarized) microscope (BM) is used to detect the physical characterization of MPs differing in color, shape, surface texture, or size. MPs come in eight common shapes: fibers, spheres, pellets, lines, sheets, flakes, foam, and fragments—the latter is the most abundant shape. A visual approach is also useful to distinguish MPs from other particles of similar size and shape (e.g., clay or algae), and for particle counting.Larger particles (size in a range from 1 to 5 mm) can be analyzed even by the naked eye, but there is a possibility of missing small and transparent MP particles in the samples [8] , [9].

4.2SPECTROSCOPY-BASED METHODS

FTIR allows accurate identification of polymers from their characteristic IR spectra due to the possession of specific IR spectra with distinct band patterns [11].

4.3CHROMATOGRAPHY-BASED METHODS

Pyr-GC-MS is a destructive but efficient method for structural MPs identification, focused on pyrolytic degradation of the sample (only 5–200 µg) and analysis of byproducts. Polymer (sub-)type(s) and organic additives can be efficiently identified according to their mass [10].

5.ECOTOXICITY OF MPS

The amount of plastic in the atmosphere has been growing for a long time, and MPs, which are just a few millimeters in size, are starting to show up in the environment. They're causing a lot of damage to marine life and nature, and they're becoming a real problem. They can found in all sorts of shapes and varieties as mentioned earlier, it is necessary to deal with this matter on an urgent basis as almost all the process lead to MP waste generation [12] , [13] .

5.1 **ACCUMULATION OF MPS IN LIVING ORGANISMS**

The accumulation and toxicity of these contaminants in living organisms act as a risk to human health. The human health is affected by the presence of MPs in the environment [14]. MPs affects organsims dermal, oral and inhalation, leading to risk factors. The metabolic transformation of PAH is impaired by interaction of metabolic enzymes with MPs, increasing their accumulation in organisms. In fish, the bioavailability of PAHs and PCBs [15-18] will be impaired due to the accumulation of polysaccharide in the liver. The release of ecological contaminants that are adsorbed by MPs will create a chain of pharmacologic changes in the environment. The real risk cannot be measured only by the specific toxicity of a pollutant. Therefore, it is necessary to link its contact and statistics to environmental pollution. Recent research shows that MPs may inhibit the bioavailability of metal in the marine environment. Some process undergoes physical-chemical changes.

5.2 TOXICITY DUE TO CHEMICAL AND PHYSICAL PROPERTIES OF MP.

Background information is provided by the physicochemical properties of PM. In aquatic environments, the bioavailability and toxicity are due to the inert nature of PM. Therefore, although the detailed description of the properties is relevant to the physical sciences, attempts are made to reveal the influence of MP on alcohol consumption, abnormal type genetic response and the environmental involvement in a thoughtful way. The potential effects of PM are mainly reflected in the physical properties and bioavailability of different species. Furthermore, it depends on the individual characteristics of the waste and, therefore, of the hunt. Carnivores, primary carnivores, can only distinguish food from substitutes supported by limited characteristics certainly due to the contribution of MPs with the same options available to them. available for their usual occupation. The physical properties of PM influence morphology and mobility in aquatic environments. Scattered bioavailability with a distribution that varies continuously at regular intervals in the aquatic environment, representing the same aspect for natural substances, with respect to degrees of muscle imbalances. completely different for microbiology. Several physical and chemical properties negatively affect plastic contaminants.

5.3 IMPACT ON AQUATIC LIFE

PM carries various toxins as additives from industrial production through the natural action of water. The distribution of microplastics is widely distributed worldwide; Fresh water, oceans and seas, as well as water columns and sediments are greatly achieved by the deep ocean. Physical effects mainly include physical and web processes, studies of MP in sweaters have argued. In the many investigations that have taken place, it has been determined that more than two hundred marine species have been affected by the web and body formation of man-made waste. Although the limit to which the physical effect affects organisms is yet to be determined, the overall web results involving relatively massive flora and fauna are remarkable when compared to the standard consume. Serious impacts on aquatic species are due to entanglement. Some of the defenseless species are sea turtles, mammals, seabirds, and crustaceans. When these animals drown in the ghost net, they suffocate and starve; once their predators appear, they will surely die. Direct and indirect input is the source of delegates' participation in the process. The cumulative effect is mainly seen at higher trophic levels such as seabirds, seals and sea lions; Fish are mainly absorbed by plastic contaminants through predation and are therefore affected. Rumor has it that the problem of gathering delegates from the waters to the seals is as high as one hundred and sixty times. PM traps often occur with relatively large marine organisms. On the other hand, PM activity is found at most levels of organic processes, such as taxa of animals, polychaetes, mussels, shellfish, fish, sea turtles, dolphins. , whales and seabirds . The main role is played by biological and chemical factors. Toxicity can be observed after ingestion of microplastics. Some polymer compounds carry out the production of plastics; Some chemicals used in the production of plastics are toxic, such as copper ions. More importantly, various toxins in the water initially measured in PM can then be desorbed into human and animal bodies. Some of the health effects are caused by polymeric compounds found in plastics. For example, styrene (PS), which is resistant to biodegradation, accumulates in the belly of fish and can travel through the bloodstream.

6.KEY CHALLENGES AND FUTURE PERSPECTIVES

As knowledge about the relationship between pollutants and microbial populations continues to grow, there are increased challenges, although far from being insurmountable, highlight the need to strengthen disciplinary knowledge to better characterize microbial reactions to pollutants at species, population and community levels.

The main pollutant being MPs is very difficult to analyze and its quantity cannot be determined easily using existing techniques.

The main gap in this till date is that there is lack of surmountable knowledge on all the pollutants present in water bodies and how many organisms it is affecting.

With the increasing population there is an increased waste generation so this matter has to be dealt with on an urgent basis and a solution for the waste generated and dumped in oceans has to be found and dealt with. Each organism on this planet gets affected due to pollution not just humans and this has to be understood by everyone.

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