



IMPACTS OF MICROPLASTICS IN FRESHWATER BODIES

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ABSTRACT

In the existing world, the production and utility of plastics has grown exponentially. The wide-ranging applications of plastics have increased plastic wastes. Through various sources, these wastes reach the freshwater bodies and pollute them, including abiotic and biotic components. These pollutants are of different shapes and sizes. The microplastics (less than 5 mm) were observed in freshwater bodies, i.e., rivers, reservoirs, lakes, ponds, etc. The microplastics are considered to be a new threat to the abiotic and biotic environment of freshwater ecosystems. The plastic contaminants pose ecological and eco-toxicological risks for the freshwater ecosystems. In this review article, the sources and impacts of microplastic pollutants have been emphasized. The plastic polluted freshwater ultimately merges into the oceans and pollutes the marine ecosystem too. It is the need of the day to pay attention to the threat of plastic pollution in fresh water bodies which adversely affects the environment universally. We need to make globally acceptable strategies and policies to check the plastic contaminated discharges into the aquatic environment.

Keywords: Plastic, Microplastics, Ecosystem, Freshwater, Marine, Biotic, Abiotic

INTRODUCTION

The usage of plastics globally has increased manifold in the last few years. Plastics are used in our day to day life, from regular household utilities to commercial

applications, industrial usages, construction materials, etc., which is damaging the environment dangerously. These plastics are comparatively cheaper, lighter, robust, and durable [1, 2].

The numerous applications and usages of plastics have instead made our life dependable on them. Ultimately these products are thrown away as waste. The wide-ranging applications of plastic products resulted in massive storage of plastic waste. Moreover, it's a well-known fact that the plastic is almost nondegradable material. These plastic products are causing pollution by spreading in various sizes and shapes. The plastics observed in the freshwater ecosystems also include the macro-plastics of more than 25 mm [3]. The macroplastics plastics get degraded in fragments and form microplastic particles less than 5 mm [4, 5]. These microplastics include films, household, and consumer products, industrial raw material, fishing nets, etc., and are accumulating in urban and rural areas, etc. Mismanagement of these pollutants is a significant threat to the environment [5].

However, the extensive use with continuously increasing production, unplanned waste management, and the nonbiodegradability of the plastics has resulted in excessive accumulation of plastic debris in

natural habitats. These microplastics get transported mostly from streams to rivers and finally to the oceans [1, 6]. The microplastics are becoming a matter of grave concern and are now considered to be a significant risk to ecology and their consequences. The freshwater bodies like rivers, lakes, etc., were found getting polluted with plastic pollutants [7, 8, 9] and were prominently observed in freshwater fishes in the form of pellets, spheres, irregular fragments, fibers, etc. [10]. The microplastics are now considered to be a severe concern to the water bodies. Their tiny size may make them easily accessible; until the benthic level organisms [11]. These particles may also contain some other harmful material along with them for the organisms of water bodies [12]. These tiny particles can easily float with currents of the aquatic ecosystems. Few microplastics may have densities lower than that of water and may get drifted to longer distances in the water bodies with the flow of water [13, 14]. The microplastics having a density higher than that of water may sink into the sediments at the bottom level [15], and few forms biofilms at the sequestration in sediments [11].

In the freshwater ecosystems, fishes are considered to be an important organism, possibly due to its nutritional and economic

value. It also generates a good amount of employment and plays a significant role in the food chain. The fishes help to regulate the food web dynamics, carbon flux and sediment process and form linkages among ecosystems as well. Fishes may ingest these microplastics, may be actively or passively. On consumption of these pollutants by fishes may create various threats like blockages in intestine, endocrine disruption, choking, etc., [16, 17]. Impacts of microplastics in freshwater bodies are known to some extent, a lot is yet to be studied and need to address their threat.

SOURCES OF MICROPLASTICS POLLUTANTS

An estimate suggests that most of the microplastics are being contributed by the inland sources which were drifted to the freshwater bodies. Observations indicate that human activities are highly responsible for these microplastics in the aquatic ecosystems. The water bodies near the residential and industrial areas had been observed in abundance with microplastics. It may be because the usage of plastics has increased exponentially.

In general, the possible potential sources may include the drainage or sewage water, runoffs from the wastewater treatment plants, industries, agriculture, shipping industry,

etc., flowing to the ponds, lakes, rivers, etc., [18, 19]. The transport pathways (waterways) may get these microplastics from various sources. These sources may include the sewage sludge used for landfills, cloth washing, plastic manufacturing, industrial and cosmetic utilities, degradation of primary macroplastics, etc. Similarly, the increased tourism and exploration have also been identified as another significant contributor of microplastics into the environment, which ultimately comes to the water bodies and increases pollution.

IMPACT ON FRESHWATER ECOSYSTEM

The microplastics may also impact the abiotic environment along with the biotic environment of the freshwater ecosystems. The water bodies have their homeostasis in which various parameters keep the water bodies potentially viable for the biota present in it. The microplastics coming along with pollutants, pose potential threats to the abiotic and biotic environment of the water bodies. The chemicals associated with the microplastics may dominate the sorption and desorption rates of the chemicals aquatic ecosystems [12, 20].

The microplastics may also be potentially dangerous to the quality of the aquatic environment. The microplastics are nondegradable and non-dissolvable in the

water. They either float on the surface or may go to benthic level or may even remain suspended and keep swimming in the water column. They may impact light penetration and affect the photosynthesis process adversely. The benthic level sedimentation may get contaminated and influence the essential and nutritional ingredients for the aquatic ecosystem. This way, the microplastics may alter the quality of pelagic and benthic ecosystems. The physicochemical parameters of water bodies may get changed due to the presence of the contaminants and, in turn, affect the biogeochemical cycles [21]. The contamination of the aquatic ecosystem may influence the biota as they may ingest the contaminants too. The effects of microplastics may get transferred among the ecosystems. Thus the microplastics in the freshwater ecosystem potentially impact the terrestrial ecosystems. Many of these freshwater organisms are prey for terrestrial insects, birds, animals, etc. [22]. The contaminated organisms of freshwater ecosystems are capable of posing life threats to the animals of other habitats. The microplastics may impact the organisms of rafting communities, egg-laying organisms, microbial communities, etc. [23, 24]. But

still, there is a need for detailed documentation of these impacts.

IMPACT OF MICROPLASTICS ON FRESHWATER ORGANISMS

The land filled debris and runoffs containing the microplastics are significant sources to contaminate the freshwater bodies. Various studies had revealed that freshwater animals like bivalves, crustaceans, tadpoles, fishes, etc., ingest the microplastics. The microplastics had been observed in the bivalves and fish intestine, liver, gut, faeces, etc. [25, 26].

Various researchers had reported the behavioral changes in these organisms. Ingestion of microplastics in fishes may cause false satiation or loss of hunger, blockages of the intestine, resulting their survival [27]. The microplastics may cause decreased or restricted movements affecting the swimming. Endocrine disruption is one of the dangerous impacts that may interfere in hormonal systems and may cause congenital disabilities and or developmental disorders. The studies have proved that freshwater organisms are prone to ingest the microplastics, but in-depth toxicity impacts on these organisms need to be studied.

Several other contaminants may also accompany the microplastics and may get ingested by the freshwater organisms. These

contaminants may include grease, oils, heavy metals, insecticides, pesticides, electronic wastes, etc., may cause further ill-effects to the freshwater organisms along with microplastics [10].

The microplastics as a vector may carry various micro-organisms, pathogens, etc., along with them to the freshwater bodies and influence the water quality. Such micro-organisms form biofilms of pathogens on the microplastics and may get ingested by the freshwater biota. Such biofilms were formed on microplastics may create a new kind of habitat for micro-organisms. This new contaminated habitats also need to pay special attention.

IMPACT ON METABOLISM OF THE FRESHWATER ORGANISMS

As mentioned earlier, the microplastics adversely affect to the freshwater bodies and its biota. It had been observed that the freshwater organisms had shown a decrease in reproduction capacity. The chemicals and other contaminants associated with the microplastics also affect the reproduction of the freshwater organisms. It was also been observed that the exposure to the microplastics might damage the internal organs like the gut, liver, buccal cavity, etc. Further, it revealed the digestive tract and gills of early-stage organisms had been

damaged. It showed that the organisms get affected in the early stage of life also. The microplastic particles may get bind to the proteins involved in metabolism in fishes and affect adversely [26, 28].

IMPACT OF FRESHWATER CONTAMINATION TO THE OCEANS

Most of the rivers and other water bodies ultimately merge into the oceans. Freshwater bodies also carry the contaminants, including the macro and microplastics, which eventually dispersed into the oceans. The polluted water brings various contaminants from municipal discharges, sewage, urban runoff, storm water, industrial spills, agricultural runoffs, etc. [29]. Therefore the freshwater resources are the main transport pathways to the oceans for plastic contamination.

It is a well known fact that the microplastics enter into the oceans through other modes also. Fishing is a significant business worldwide. The nets and associated equipment used for fishing are usually made up of plastics. The transportation through the oceans also causes dispersal of plastics into the oceans. The shipyards and docks are also a possible source for plastic contamination. Tourism and the Sea exploration are also adding further plastic contamination.

CONCLUSION

The studies and observations had revealed that microplastics are adversely affecting the water bodies. Further, it may damage and affect normal behavior and may change the normal metabolism of the aquatic animals. Moreover, these may affect the terrestrial ecosystem too.

The scarcity of data availability of the microplastic impacts on the freshwater ecosystem emphasizes the need for more research. The plastics are tough to degrade and, by its virtue, are harmful to any of the environment. We are yet to discover the impacts in detail of these microplastics on the freshwater ecosystems, aquatic animals and human beings. The literature survey suggests that, at present, most of the studies are going on about marine environments, but the freshwater ecosystems also need to pay more attention.

Therefore, the study suggests considering followings things:

1. Monitoring of the microplastics in the freshwater bodies, and to understand the possible sources of contaminants. Besides this, the water quality of the freshwater bodies needs to be investigated.
2. The possible damages due to the associated particles, chemicals, pollutants, etc., to be identified. These foreign bodies,

along with the microplastics may severely affect the biotic and abiotic freshwater environments.

3. The possible interactions and combinations among the existing pollutants with microplastics are supposed to be studied further.
4. Studies on impacts of microplastics on the freshwater animals, and the food web should be conducted on priority.
5. The policies, strategies need to be formed and to be implemented to avoid plastic contamination to save the freshwater bodies.

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