Plastics Supremacy

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ABSTRACT

Plastic is everywhere on the planet Earth. There is a wide range of products that contain plastic materials in their composition. The vital reason behind the wide range of plastic products lies under characteristic properties of this material such as flexibility under pressure, resistance against acid, low weight along with low cost. Thousands of marine species suffer and fight for their lives because of all this plastic that is used and then disposed of in the oceans. At the end of the food chain, it affects the humans that consume fish.

Introduction

Plastic is a polymeric material in which thousands of chemical units and monomers are polymerized. Chemically, plastics are made up of compounds of carbon, along with the inclusion of some other elements. Chemical compounds are added to rubber and resins to make plastics. The purpose behind the addition of these plastic additives is to provide some unique mechanical properties according to the demand for the material or for what it is going to be used. The plastic additives may show interaction with components of edible products which are being packed [2]. Carbon-based synthetic compound Bisphenol-A which is also a plastic additive tends to migrate into food products from the packaging material and cause severe health damage to the human body on exposure [1].

Usage-Range of Products

Bisphenol-A has main usage as an intermediate in the formation of many useful products by performing various functions such as binding, hardening as well as plasticizing. Moreover, BPA has applications in various industrial fields like the chemical industry, plastics industry, construction, and building industry. Specifically, ally major proportion of BPA is being consumed in the plastics industry in polymeric syntheses such as polycarbonate resins (71%), epoxy resins (27%), unsaturated polyester, polysulfone, polyetherimide and polyacrylate resins (25%) [7].

Microplastics

The broken-down fine debris of plastic, industrial plastic, and consumer waste that end up in the environment is called microplastics. These microplastics end up in water bodies and are harmful to all animals and especially aquatic life. They cause physical damage and also provide a site of growth for harmful pathogens [8].

Environmental Sources

BPA does not occur naturally but its production is linked with commercial needs that are ultimately released into the environment [15]. In the case of the aquatic environment, BPA shows solubility in water in the range of 120 to 300 µg/ml. Normally BPA is exposed to the aquatic environment through the release of wastewater from the factories that are synthesizing it. Because BPA cannot be completely released from water due to its solubility in water during wastewater treatment. High levels of BPA also found in the leachates from dicey wastewater landfills ranged from 1.3 – 17,200 ng/ml [18]. BPA is also found in river water to some extent as it is degraded in the presence of oxygen under an aerobic environment. Studies have also shown that BPA is present at higher concentrations in seawater as it can remain protected from degradation for about 30 days as compared to river water when treated at 20°C. So marine water organisms are more likely to contaminate with BPA than freshwater organisms. A significant route of human exposure also happens in the aquatic environment or by the consumption of seafood or freshwater fish that is contaminated by BPA [11]. From the air, the possibility of transportation of BPA is relatively less than 0.0001% than that of water about 30% [10].

Distribution of microplastics

Different case studies show the presence of microplastics at different percentages in different aquatic life. Microplastics were found in an alerting amount in *Dicentrarchus labrax* (42 %), *Trachurus trachurus* (42 %), and *Scomber colias* (62 %) specimens from Portuguese coastal waters (NE Atlantic Ocean). The NE Atlantic Ocean water is polluted with microplastics [12].

Ther microplastics might be taken up by fish directly from the seawater passively (e.g., gill water filtration) and actively (i.e. ingested by confusion with prey) and through the ingestion of contaminated prey [13].

These microplastics come from industrial waste, fishing nets and ropes, fish boats, and the active dumping of household waste in the water. Different studies suggest that predator fish may also actively ingest microplastics, this may be due to the resemblance of these pollutants to the prey they usually consume as food. Certain types have been shown to ingest fibers more than fragments because they resemble prey [3].

Mechanism of pathogenesis in fish

The ingested false microplastics can cause physical damage to aquatic life. If lodged in the intestines can release toxins causing toxemia. The ingested plastics also produce lesions and ulcerations which can be a site for pathogens and infections [4]. The unabsorbed microplastics can also be secreted out of the body of fish along with feces [5].

Wounded and ulcerated intestines may have increased chances of microplastic absorption. The absorption may be due to phagocytosis, pinocytosis, or exocytosis but the exact mode of absorption and distribution is still not clear. In a study, an idea was presented that fine particles as little as 150µm may be taken up by the cells actively from the liver, kidney, stomach, and intestines. The absorption of particles of plastic is also thought to be through the skin but wounded skin increases the chances of such an occurrence. Micro and nanoparticles are found in different parts of the bodies of the fish but their modes of absorption and distribution need further studies [16].

The microplastic in the gills causes a lot of damage physically, causing wounds and lacerations. Damaging the filaments and reducing the filtration efficiency of the gills. The damaged or blocked gills can cause dyspnea in the fish and can even cause the death of fish [14].

Serving as pathogen vectors

Microplastics found in the water provide a chance for many pathogens to grow. *Vibrio spp* are among the pathogens most abundant in such contaminated waters. *Vibrio parahaemolyticus* has been found in the North and Baltic seas, *V. alginolyticus* in the North Sea and lake Macquarie on different plastic pipes and other plastic dumps [19].

Aeromonas salmonicida is confirmed to have plastic as a vector [17]. Another pathogen *A. salmonicida* is also present in plastic found in wastewater. *Leptolyngbya* spp which causes the pathogenesis of corals are also found to be present in plastic making it their habitat [20].

Accepted Levels

It is necessary to set a limit on BPA consumption by human beings through packaging material for sake of health safety purposes. Because very trace amounts of BPA caused estrogenic effects when experiments were conducted inside the laboratory on animals to synchronize these results with human beings. Therefore, many health organizations give various accepted ranges of BPA after conducting significant experiments. EFSA declared the high margins over the BPA safe range that is known as "Tolerable Daily Intake (TDI)". Its value is typically 4µg/kg body weight/day. According to another report that is conducted on the scientific evaluation of BPA in 2004, human exposure to BPA should be in-between the range of 0.001 to 0.1 mcg/kg [9].

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Health Hazards

Various studies proved the detrimental effects of BPA on humans as it has estrogen-like properties. Approximately 125 studies were conducted on the fund of some government agencies and the results showed that BPA is significantly responsible for structural and neurochemical changes throughout the brain, disruption in the formation of some hormones, interference in sperm production in males, and also some disorders related to the immune system. Along these, BPA exposure is also associated with diabetes, obesity, and liver dysfunction [6].

Conclusion

The role of plastic products in every field of life cannot be denied because these products have gained global use. But how one can overtake marine life from plastic's hazardous chemicals while knowing about the damage they are doing? Aquatic life comprising on fish, seabirds, turtles, and whales i.e. superficially eat tiny debris of plastic as their prey and then suffer all their lives.

References

[1]. Adeyi AA and Babalola BA, 2019. Bisphenol-A (BPA) in foods commonly consumed in Southwest Nigeria and its human health risk. *Scientific reports* 9:1-13.
[2]. Bhunia K et al., 2013. Migration of chemical compounds from packaging polymers during the microwave, conventional heat treatment, and storage. *Comprehensive Reviews in food Science and food Safety* 12: 523-545.
[3]. Blaxter JHS, 1980. Vision and feeding of fishes. In: Bardach, J.E., Magnuson, J.J., May, R.C., Reinhart, J.M. (Org.). Fish behaviour and its use in the capture and culture of fishes. ICLARM Conference Zˇ. Proceedings 5, Manila, Philippines, 5:32–56.
[4]. Carpenter EJ et al., 1978. Polystyrene spherules in coastal waters. *Science* 178: 749–750.
[5]. Dawson AL et al., 2018. Turning microplastics into nanoplastics through digestive fragmentation by Antarctic krill. *Nature Communications* 9: 1001.
[6]. Erler C and Novak J, 2010. Bisphenol a exposure: human risk and health policy. *Journal of pediatric nursing* 25: 400-407.
[7]. Groshart CP et al., 2001. Chemical study on bisphenol A. *Rapportnr* 027: 1-94.
[8]. Jabeen K et al., 2018. Effects of virgin microplastics on goldfish (Carassius auratus). *Chemosphere* 213: 323–332.
[9]. Kamrin MA, 2004. Bisphenol A: a scientific evaluation. *MedGenMed : Medscape general medicine* 6.
[10]. Kang JH and Kondo F, 2005. Bisphenol A degradation in seawater is different from that in river water. *Chemosphere* 60(9): 1288-1292.
[11]. Kang JH et al., 2006. Human exposure to bisphenol A. *Toxicology* 226: 79-89.
[12]. Lusher AL et al., 2014. Microplastic pollution in the North East Atlantic Ocean: validated and opportunistic sampling. *Marine Pollution Bulletin* 88: 325–333.
[13]. Lusher AL et al., 2013. Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel. *Marine Pollution Bulletin* 67(1–2): 94–99.
[14]. Movahedinia A et al., 2012. Gill histopathological lesions of the Sturgeons. *Asian Journal of Animal and Veterinary Advances* 7: 710–717.
[15]. Tsai WT, 2006. Human health risk on environmental exposure to Bisphenol-A: a review. *Journal of Environmental Science and Health Part C* 24(2):225-255.
[16]. Vignardi CP et al., 2015. Genotoxicity, potential cytotoxicity and cell uptake of titanium dioxide Nanoparticles in the marine fish Trachinotus carolinus (Linnaeus, 1766). *Aquatic Toxicology* 158: 218–229.
[17]. Viršek MK et al., 2017. Microplastics as a vector for the transport of the bacterial fish pathogen species Aeromonas salmonicida. *Marine Pollution Bulletin* 125: 301–309.
[18]. Yamamoto T et al., 2001. Bisphenol A in hazardous waste landfill leachates. *Chemosphere* 42(4), 415-418.
[19]. Yasunaga N and Yamamoto N, 1977. Characteristics of bacterial strains isolated from so-called vibriosis of cultured red sea bream in the winter of 1977. *Fish Pathology* 12: 209–214.
[20]. Zettler ER et al., 2013. Life in the "plastisphere": Microbial communities on plastic marine debris. *Environmental Science and Technology* 47: 7137–7146.