Chapter 7

Microplastics Issues in Seafood and its Control Measures

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Introduction

Microplastics are defined as plastic materials or fragments of length 0.1µm to 5 mm, are most likely the most numerically abundant plastic debris items in the ocean today, and can be found in various environments, including the oceans, where they can significantly impact marine life. One concern related to microplastics is their association with seafood, which has raised questions about potential health impacts on humans. Microplastics (MPs) are a heterogeneous mixture of plastic polymers with a size of less than 5mm, which have become ubiquitous in the marine environment due to extensive plastic pollution (Thompson *et al*., 2004). The presence of these particles in marine organisms raises increasing concerns over animal welfare and food safety, given that seafood compromises over 17% of animal protein consumption by humans globally (Murray and Cowie,2011; FAO,2018). Therefore, it is extremely important that the risk seafood presents to consumers, regarding exposure and health effects, is accurately quantified. To do this comprehensively, not only should MP contamination be quantified across the breadth of globally consumed organisms, but the MP

Microplastics in the marine environment - Trending global environmental issue

Microplastics can come from various sources, including the breakdown of larger plastic items, microbeads in personal care products, and industrial discharges. They can enter the oceans through wastewater runoff, rivers, and coastal areas. Here are some key points to consider regarding microplastics in seafood and their potential health impacts: Larger plastic particles, which ultimately reach oceans in due course of time, degrade into smaller micro and nano plastics because of photo-oxidation due to sunlight, wave abrasion due to water wave's physical stress. In 2014, the estimated number of floating plastic particles in the world's oceans was 5.25 trillion, of which 4.85 trillion were microplastics (GESAMP, 2019). Microplastics are being classified as primary and secondary microplastics. Primary microplastics are engineered plastic particles manufactured as microbeads, capsules, fibers, or pellets and used in the manufacture of several cosmetic products, paints etc. And plastic

materials that, due to several biological, chemical, and physical processes, disintegrate into smaller plastic fragments in the course of time are known as secondary microplastics.

Bioaccumulation and Biomagnification of microplastics in aquatic organisms and humans

Marine organisms, including fish, shellfish, and plankton, can ingest microplastics. Microplastics are the major cause of concern because their size range mimics the prey size many aquatic organisms ingest. These particles can accumulate in the digestive tracts and tissues of these animals. As larger fish consume smaller fish, there is potential for biomagnification, meaning the concentration of microplastics may increase up the food chain. Most aquatic organisms, including zooplankton, invertebrates, fish, bivalves, birds, cetaceans, and larger mammals, incidentally consume MPs from sediment or the water column, mistaking them as food. These plastics are eaten by lower-tropic-level organisms such as mussels, oysters or copepods, and small fishes, then biomagnified to animals at higher tropic levels that feed on them. Obviously, humans are exposed to microplastics through the consumption of species of commercial importance for fisheries, and aquaculture is significant as this seafood is a recognized source of contaminants in the human diet. About 690 marine species are known to encounter marine litter and microplastics. Plastics contain a variety of chemical additives including fillers, plasticizers, flame retardants, UV and thermal stabilizers, pigments, and antimicrobial agents which are introduced during the manufacturing process to achieve the desired performance and appearance criteria which on disintegration may pose several health impacts as it can alter the hormonal balance of the living organism and the additive PCBs is a carcinogenic compound.

Microplastics' physical and chemical properties facilitate the sorption of contaminants to the particle surface, serving as a vector of contaminants to organisms following ingestion and posing potential health effects. Many recent research studies on Indian beaches, coastal waters, and commercially available finfish and shellfish (especially shrimp and bivalves) revealed the occurrence of microplastics. Recent research reveals that globally on average each human is ingesting 5 grams of plastic every week, the equivalent of a credit card in the form of microplastics. Various studies have confirmed the presence of microplastics in a broad range of marine organisms (Gambardella et al., 2017). The ingestion of these microplastics can be extremely hazardous to organisms, as they can cause blockages in the digestive tract, oxidative and pathological stress, inhibit growth rate, and reproductive disorders. From the available studies, microplastics have been observed in the gastrointestinal tract in 11 out of the 20 most important species and genera of finfish that contribute to global marine fisheries (FAO, 2016)

and in shrimps and lobsters of coastal waters of Europe (Devriese et al., 2015). Among bivalves lowest incidence of microplastics is found in European waters which is 0.5 microplastic items/gram of soft tissue and the highest incidence is observed in Newfoundland, Canada which is 50 microplastic items/gram of soft tissue. But most recent studies conducted in India, the second largest fish-producing country reveal the presence of microplastics in commercially important finfishes, shrimps, and bivalves is many folds higher than that observed in the other parts of the world.

Incidence of microplastics in commercially important seafood

The ubiquitous spread of microplastics in Indian marine waters results in inevitable interaction with a lot of commercially significant organisms like shrimp, bivalves, predatory fishes, etc. Among these organisms, bivalves are excellent filter feeders and are of particular interest because their extensive filter-feeding activity exposes them directly to microplastics present in the water column. The incidence of microplastic accumulation is 27 times higher than in fish and approximately filter 24 liters per day and accumulates these microplastics in their gut and tissues rapidly within hours. Thus they can be used as bio indicators for the plastic pollution status of that region. Commercially important, widely consumed and exported bivalves and gastropods of India like *Perna viridis,* the green mussel (Japanese - Igai, Spanish – Mejillon) *Meritrix casta,* the yellow clam (Japanese - Nimaigai, Spanish- Almeja), *Babylonia spirata* popularly called as baigai, *Katelysia opima* from different coasts are reported to contain microplastics. These clams are exported to different countries like Japan, Taiwan, China, Mexico, Hong Kong, South Africa and Italy. About 80% of Indian clam meat is imported by Japan followed by Spain and China. Yellow clam led the international export, touching 721.88 tons valued at Rs.10.67 lakhs during 2016-’17 (MPEDA, personal communication, 2018). Most of the yellow clam, targets international markets at Japan and Thailand. Commercially consumed bivalves from Chinese waters are estimated to contain 2.1 to 10.5 items/gram, and bivalves from European waters of France, Germany, Belgium, and Norway are estimated to contain an average of 0.5- 1 items/gram. But in a recent study, the most consumed bivalves of the Tamil Nadu coast is 4-6 items/gram and astonishingly that of the Mumbai coast is 52.71 to 77.23 items/gram of bivalve meat and 5- 12 items/gram of gut of shrimp which implies the intense anthropogenic activities of that area. This indicates the present drastic and dangerous situation. If this situation continues, in the near future there is the possibility of quality issues on Indian seafood imports in foreign countries due to its ridiculous microplastic content.

Implications for Human Health, Food Security, and Indian International Trade

Now microplastics have gained increased attention from regulatory bodies of different countries over the past few years as they may cause reduced body growth, intestinal damage, physiological or oxidative stress, and inflammation, effects on the immune system, hormonal dysregulation, aberrant development, cell death, general toxicity and altered lipid metabolism in humans. Some jurisdictions like California have passed laws related to microplastics requiring state regulators to develop standards and incorporate them into regulations. Fish (finfish and shellfish) and its products are major important products among Indian agricultural exports earning US$ 6.3 million (45,106.89 crore INR) in 2017-18. Seafood comprises 10% of the total exports of India and nearly 20% of all agricultural exports and India has approximately 20-22% of the world shrimp trade. As microplastics became a global environmental concern and now as it's under continuous global scrutiny. Considering the deleterious health effects caused by microplastics due to the chemical additives added to them, toxic chemicals adsorbed to their surface, and harmful pathogens attached to them in the near future many countries may categorize it as a food hazard associated with fish/shellfish and may include it in mandatory fish product quality and safety standards. If Indian seafood exports fail to comply with those safety standards it will be a major blow to the economy, and result in the rejection of consignments, and exporters may incur heavy losses.

Consumption of Seafood Contaminated with Microplastics:

When humans consume seafood that contains microplastics, there is the potential for these particles to enter the human digestive system. The extent of human exposure to microplastics through seafood consumption is an area of ongoing research.

Potential Health Impacts:

The health impacts of ingesting microplastics are not yet fully understood, and research is ongoing. Some concerns and potential risks include:

Physical Irritation: Microplastics may cause physical irritation and damage to the digestive tract.

Chemical Exposure: Microplastics can adsorb toxic chemicals from the environment, and there is concern that these chemicals could be released into the body upon ingestion.

Inflammatory Responses: Microplastics may trigger inflammatory responses in the body's tissues.

Reducing Microplastic Exposure:

Many countries and organizations are starting to address the issue of microplastics in seafood. Some have set limits on the amount of allowable microplastics in food products. Additionally, monitoring and research efforts are ongoing to understand the extent of

contamination and potential health risks. To reduce exposure to microplastics through seafood consumption, individuals can take the following steps:

- Choose seafood from sources known for good environmental practices and monitoring.
- Avoid consuming seafood products that are more likely to contain microplastics, such as bivalves (mussels, clams) or bottom-feeding fish.
- Minimize single-use plastic consumption to help reduce the input of microplastics into the environment.
- It's important to note that the long-term health effects of microplastic exposure through seafood consumption are still an active area of research, and the overall risk to human health is not yet fully understood. As such, ongoing research and monitoring are crucial to better assess the potential risks and inform regulatory actions if necessary.

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