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Perspective

Protecting Aquaculture from Microplastic Contamination: Innovations and Preventative Measures

Xuan Chun*

Department of Marine Biotechnology, Xiamen University, Xiamen, China

DESCRIPTION

Microplastics, defined as plastic particles less than five millimeters in size, have become a significant environmental concern due to their widespread distribution in aquatic systems. These particles, originating from degraded plastic waste and industrial processes, infiltrate freshwater and marine environments, posing risks to aquatic organisms and ecosystems. The aquaculture sector, vital for global food security, faces challenges from microplastics, as their presence can impact water quality, cultured species and human health.

Microplastics enter aquaculture environments through multiple sources, often related to human activities and aquaculture practices. Understanding these sources is vital to addressing the problem effectively. Aquaculture facilities often contribute directly to microplastic pollution through the use of plastic-based materials. Common items such as fishnets, ropes and feed bags degrade over time, releasing microplastic particles into the water. Pelletized fish feeds, stored or transported in plastic containers, may also introduce microplastics if these containers degrade. Runoff from agricultural fields and urban areas often carries microplastics into nearby aquaculture facilities. These particles originate from plastic mulch, synthetic fertilizers and urban litter that break down under environmental conditions. Industrial effluents also contribute to microplastic contamination in water bodies used for aquaculture. Atmospheric deposition represents another route through which microplastics enter aquaculture systems. Wind and rain carry airborne microplastic particles, depositing them into open ponds or water supplies connected to aquaculture facilities. Aquaculture environments often share water resources with natural aquatic systems, such as rivers and lakes. Microplastics in these shared water sources can migrate into aquaculture setups, where they accumulate over time. Once introduced into aquaculture environments, microplastics move through various pathways, affecting both the water column and organisms within the system.

Microplastic particles often remain suspended in the water column due to their small size and low density. They can be ingested by filter-feeding organisms, which mistake them for food. This ingestion introduces microplastics into the aquaculture food chain, potentially affecting fish, shrimp and mollusks. Over time, heavier microplastic particles sink to the bottom, accumulating in sediments. These particles can persist for long periods, acting as a source of contamination for benthic organisms. Sediment-dwelling species, often an integral part of aquaculture systems, are at risk of ingesting these particles. Cultured species are often fed supplementary diets in aquaculture. If feed contains microplastic contaminants, they can migrate directly into the digestive systems of farmed organisms. Studies have shown that microplastics can pass through the gut lining, accumulating in tissues and organs. Microplastics in aquaculture systems may also migrate to adjacent ecosystems, especially in open-water facilities. Currents and tidal movements can carry these particles into nearby marine or freshwater habitats, expanding the scope of contamination. Microplastics pose a range of risks to aquaculture environments, affecting both the ecological balance and the productivity of farmed species. Ingesting microplastics can lead to physical and physiological stress in farmed species. These particles may block digestive tracts, reduce feeding efficiency and cause internal injuries.

Over time, the accumulation of microplastics can impair growth, reproduction and immune responses, reducing the overall health and market value of aquaculture products. Microplastics often act as carriers for harmful chemicals, including pesticides, heavy metals and persistent organic pollutants. These chemicals can leach from the particles and enter the tissues of farmed species. Consuming contaminated aquaculture products can have long-term health implications for humans. The presence of microplastics can alter the physical and chemical properties of water, affecting dissolved oxygen levels and turbidity. Poor water quality impacts the growth and survival of aquatic organisms, increasing operational costs for aquaculture facilities. Microplastic contamination reduces the quality of aquaculture products, affecting consumer confidence and market demand. Stricter regulations and testing requirements for microplastic levels in seafood may increase operational costs for farmers.

Correspondence to: Xuan Chun, Department of Marine Biotechnology,, Xiamen University, Xiamen, China, E-mail: xuan@chun.edu.cn

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Due to the impact of microplastics on aquaculture requires a combination of preventative measures, technological innovations and policy interventions. Minimizing the reliance on plastic materials in aquaculture systems is a fundamental step. Using biodegradable or reusable alternatives for nets, ropes and feed bags can significantly reduce direct microplastic inputs. Proper maintenance and timely replacement of equipment can also prevent plastic degradation. Effective waste management practices are critical for reducing microplastic pollution. Facilities should implement measures to collect and recycle plastic waste generated during operations. Proper disposal of feed bags and other materials can prevent them from entering the environment. The aquafeed industry can contribute by ensuring that feed production processes avoid microplastic contamination. Using natural or plant-based packaging materials for feed storage and transport is another practical solution.