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Health and Environmental Risks of Microplastics in Shrimp Ponds

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Abstract

Microplastics (MPs) are tiny plastic particles resulting from the degradation of larger plastics or commercial production of plastic materials, pose significant environmental and ecological threats. In shrimp farming, MPs originate from plastic equipment used in aquaculture and from external sources such as polluted water. The microplastics that are present in the shrimp pond may affects the shrimp health, which may lead to several health issues like digestive issues, abnormal swimming behaviours, oxidative stress, increase the vulnerability of disease and reproductive challenges in the shrimp. These microplastics disturb the shrimp population as they are primarily deposited in the intestinal tracts and hepatopancreas of the shrimps. The most abundant microplastic in the shrimp pond is microfibers and polyethylene. To solve this issue, healthy aquaculture techniques and initiatives to limit plastic pollution are required. Further investigation is needed to determine the long-term effects of MPs on aquatic ecosystems and identify suitable mitigation strategies.

Keywords: Aquatic animal health, Microplastics, Plastic pollution, Shrimp farming

Introduction

Plastics are easily moldable, durable and have low production costs. Due to these properties, plastics are frequently used by humans (Azizah *et al.*, 2020; Browne *et al.*, 2007). Microplastics are small plastic particles formed through commercial product development, as well as through the breakdown of larger plastics. It is assumed that an internal source of microplastics enters the shrimp pond through the use of plastic equipment. The external sources responsible for the entry of microplastics in shrimp ponds are contaminated water and some other human activities *etc*. Microplastics may enter shrimp ponds by using water from various external sources (chemicals, roads and industrial effluents), *i.e.*, rivers, lakes, the sea and groundwater *etc*. Maintenance containers, nets, fishing gear, water pipes and wiring are some of the applications for this type of plastic equipment. Plastic materials used in shrimp ponds will discharge the microplastics into the ponds.

Impact of Microplastics on Shrimp

Microplastics cause threat to shrimp pond. The size of microplastics is less than 5 millimetres in size; shrimp intake this microplastics when they are accumulated in pond water and can affect their health by entering into their food chain. Almost all shrimp have MPs in their gills, gastrointestinal tract and muscles. Polyethylene is the most common MP that affects and exists in the marine environment and shrimp ponds; microfibers are more abundant than other plastics, such as fragments, films, pellets and so on. Shrimps are a valuable aquatic organism that are consumed by humans, so understanding the extent of microplastic contamination in this organism is critical for assessing the potential risks to human health. Although aquaculture is a key supplier of seafood globally, the occurrence of MPs in the wild has received more attention than in aquaculture environments (Zhu *et al*., 2019). The worldwide shrimp production was approximately 6.5 million tons in the year of 2020, in this *P. vannamei* is cultivated around 5.4 million tons.

The largest source of MPs is linked to source water and feed; it can accumulate in various organs of shrimp, with the highest abundance in the hepatopancreas. Microplastics

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(MPs) can negatively impact shrimp in a number of ways, including:

1. Digestive Issues

When the shrimp eats a microplastic contaminated food, the tiny particles of this microplastic reach the digestive tract of the shrimp *via* food materials. When shrimp ingest these food materials containing microplastics, it may result in gastrointestinal tract damage; it disrupts the normal digestive process of the shrimp and causes inflammatory limitations (Lusher *et al.*, 2013). Even nutrition absorption in the shrimp is affected which ultimately causes malnutrition or low immunity in the shrimp.

2. Abnormal Swimming

MPs can cause abnormal swimming behaviour and reduced swimming performance. Microplastics have been found to contain toxic compounds that may harm the shrimps' nervous system. The shrimp swimming mechanism is widely controlled by the nervous system. When these toxins or chemical compounds from microplastics come in contact with the nervous system, it may results in the irregular swimming actions, which include erratic movements and reduced mobility.

3. Oxidative Stress

Microplastics may result in oxidative stress in marine organisms by making an imbalance in their production of reactive oxygen species (ROS) inside their own bodies (Mattsson *et al.*, 2022), resulting in cellular damage from the accumulation of these toxic molecules, primarily impacting the shrimp's hepatopancreas and gills when ingested; this is considered an important threat to shrimp health because it may affect their normal physiological functions and potentially impact their survival rates. MPs can result in lipid peroxidation, which can lead to a decline in the quality of the shrimp meat.

4. Disease Outbreak

Microplastics mainly affect the immune system of shrimp; leading to increased spread of diseases in shrimp like white spot syndrome (WSSV). Microplastics also can serve as a tadpole vector for bacteria and viruses that may contribute to the disease spread and the mortality rate of shrimp.

5. Reproduction Issues

Shrimp reproduction is badly affected by the microplastics. It results in the lesser production of eggs, limiting the fertilization process, disturbing the development of gonads and causing abnormalities in the offspring of the shrimp. Due to this, shrimp cannot reproduce effectively.

Detection and Measurement of Microplastics

Many detection and identification techniques are available for microplastics in shrimps. The process typically includes the following steps:

1. Visual Inspection

One of the most simple methods for microplastics identification is visual inspection. Microplastics are discovered with the naked eye or with the aid of a microscope. The colour and shape of the microplastics can be identified by visual inspection.

2. Fourier Transform Infrared Spectroscopy (FTIR)

The diagnostic investigations for plastic polymers are performed using FTIR. It is a strong tool that provides information about their specific bonds of plastics. Visible microplastics and plastic debris are commonly detected by conventional FTIR, but for the detection of small microplastic particles, micro-FTIR (µ-FTIR) is used.

3. Raman Spectroscopy

Raman Spectroscopy is a non-destructive method for the microplastics identification in environment. The vibrational modes of molecular bonds were diagnosed by providing distinct fingerprints for different polymers. Even 1 µm-sized small microplastic particles can be detected.

4. Pyrolysis-GC-MS (Gas Chromatography-Mass Spectrometry)

The volatile and tiny particles that are resulted from the heating of microplastics are isolated and they were determined by Gas Chromatography-Mass Spectrometry (GC-MS).

Conclusion

The presence of microplastics in the shrimp pond affects the natural environmental conditions. Sediments, water and animals in the pond, such as shrimp, are affected by microplastics. These tiny particles are entering the food chain of the shrimp; this leads to the threat to shrimp health and also for humans. Shrimp can consume microplastics directly from the water or from their food materials, potentially causing digestive difficulties, physical harm and decreased growth rates. The studies pointing out the necessity of reducing the plastic pollution and establishing a healthy aquaculture practice to mitigate the consequences of microplastics. Advanced research is needed for understanding microplastic pollution and its long-term effect on aquatic environments.

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