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Accumulation and Impact of Polystyrene Microplastics on Juvenile *Eriocheir sinensis:* Unveiling Oxidative Stress Effects in Liver Tissues

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Abstract

In the realm of marine ecosystems, the pervasiveness of microplastics presents a potential burgeoning global menace to aquatic life forms. This current study sets out to unravel the repercussions of microplastics on the growth, accumulation, and oxidative stress response in the liver of *Eriocheir sinensis*. To this end, we examined the deposition of fluorescent microplastic particles (with a diameter of 0.5 μm) within the gill, liver, and gut tissues of *E. sinensis*, which were subjected to a concentration of 40000 μg/L over a period of 7 days. A comprehensive 21-day toxicity assessment showcased a decline in the rate of weight gain, specific growth rate, and hepatosomatic index of *E. sinensis* with escalating microplastic concentrations (ranging from 0 μg/L to 40000 μg/L). Pertinently, the enzymatic activities of AChE (acetylcholinesterase) and GPT (glutamate pyruvate transaminase) were observed to be lower in crabs exposed to microplastics compared to the control group. Furthermore, GOT (glutamate oxaloacetate transaminase) activity demonstrated an initial surge following exposure to lower microplastic concentrations, followed by a continuous descent as concentrations increased.

Keywords: Superoxide dismutase • Aspartate transaminase • Glutathione

Introduction

Plastic pollution has emerged as a global environmental concern, with microplastics being recognized as a significant contributor. Microplastics, defined as plastic particles smaller than 5mm in size, are pervasive in aquatic ecosystems and pose potential risks to aquatic organisms. One such organism, the Chinese mitten crab (*Eriocheir sinensis*), plays a vital ecological role in freshwater and estuarine habitats. Recent studies have indicated the alarming accumulation of polystyrene microplastics in juvenile *E. sinensis* and the subsequent induction of oxidative stress effects in their livers. This article delves into the implications of this accumulation and its potential impact on the health of these crabs [1].

Eriocheir sinensis, commonly known as the Chinese mitten crab, is a species of crab native to East Asia. These crabs have a unique life cycle that involves both freshwater and marine environments, making them particularly susceptible to various environmental stressors, including microplastic pollution. Recent research has revealed that juvenile *E. sinensis* are ingesting polystyrene microplastics, likely due to their filter-feeding behavior and the widespread distribution of microplastics in their habitats. A study conducted by demonstrated the presence of microplastics in the gastrointestinal tracts of juvenile *E. sinensis* collected. The study found that these crabs had ingested a significant quantity of polystyrene microplastics, with particle sizes ranging. The accumulation of microplastics in these organisms is concerning, as it can lead to various adverse effects on their health [2].

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Literature Review

Notably, the activities of key antioxidants, including Superoxide Dismutase (SOD), Aspartate Transaminase (GOT), Glutathione (GSH), and Glutathione Peroxidase (GPx), exhibited an upsurge in specimens exposed to lower microplastic concentrations (40 and 400 μg/L) in contrast to the control group, only to diminish in organisms exposed to higher concentrations (4000 and 40000 μg/L). Conversely, the activities of Acetylcholinesterase, Catalase (CAT), and alanine aminotransferase showed significant diminishment in organisms exposed to microplastics compared to their control counterparts [3].

Intriguingly, the expression of genes responsible for encoding antioxidants such as SOD, CAT, GPx, and glutathione S-transferase in the liver exhibited a fluctuating pattern; an initial increase followed by a decrease upon exposure to escalating microplastic concentrations. Meanwhile, the microplastic exposure prompted an escalation in the expression of the gene encoding p38 within the MAPK signaling pathway, while significantly dampening the expressions of genes encoding ERK, AKT, and MEK.

The outcomes of this study unveil the proclivity of microplastics to amass within the tissues of *E. sinensis*, instigating a detrimental impact on growth. Furthermore, the interaction with microplastics culminated in damage and provoked oxidative stress within the hepatopancreas of *E. sinensis*. These findings assume pivotal significance by furnishing fundamental biological data for both environmental and human risk assessments concerning microplastics of heightened concern [4].

Discussion

Oxidative stress effects in the liver

Oxidative stress occurs when there is an imbalance between the production of Reactive Oxygen Species (ROS) and the ability of an organism's antioxidant defense system to neutralize them. Exposure to microplastics has been associated with the induction of oxidative stress in various aquatic

organisms, including fish, mollusks, and crustaceans. In the case of E. sinensis, the accumulation of polystyrene microplastics in their gastrointestinal tracts has been linked to oxidative stress effects in their livers.

The liver is a vital organ responsible for detoxification, metabolism, and energy storage. Research has shown that microplastics, once ingested, can translocate to the liver and trigger oxidative stress responses. The accumulation of ROS in the liver cells can lead to lipid peroxidation, DNA damage, and protein oxidation, ultimately compromising the organ's functionality. In *E. sinensis*, oxidative stress in the liver could have cascading effects on overall health and survival [5].

Implications for ecosystem health

The accumulation of polystyrene microplastics in juvenile *E. sinensis* and the subsequent induction of oxidative stress effects in their livers raise concerns about the broader implications for aquatic ecosystems. *E. sinensis* plays a crucial role in nutrient cycling and food webs, and any adverse effects on their population could disrupt ecosystem stability. Additionally, the potential transfer of microplastics and their associated toxic effects through the food chain could impact other species, including those consumed by humans. As *E. sinensis* is harvested for both commercial and cultural purposes, the presence of microplastics and their potential health impacts may have implications for human health as well.

Mitigation and future research

Addressing the issue of microplastic pollution requires a multifaceted approach, including reducing plastic waste at its source, improving waste management practices, and developing environmentally friendly alternatives to plastic. In the case of *E. sinensis*, understanding the mechanisms underlying microplastic ingestion and oxidative stress responses is essential for designing effective conservation and management strategies. Future research should focus on elucidating the long-term effects of microplastic accumulation on *E. sinensis* populations, as well as assessing the potential for transgenerational impacts. Furthermore, studying the interactions between microplastics and other environmental stressors, such as pollutants and climate change, can provide a comprehensive understanding of the challenges faced by aquatic organisms [6].

Conclusion

The accumulation of polystyrene microplastics in juvenile *Eriocheir sinensis* and the resulting oxidative stress effects in their livers highlight the urgent need to address plastic pollution in aquatic ecosystems. These findings underscore the interconnectedness of environmental health, species survival, and ecosystem stability. By taking proactive measures to reduce plastic pollution and conducting rigorous research, we can strive to safeguard the health of *E. sinensis* and other aquatic organisms, ensuring the sustainability of our valuable freshwater and estuarine habitats.

Acknowledgment

None.

Conflict of Interest

None.

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