

Effects of polystyrene nanoplastics on apoptosis, digestive enzymes, and intestinal histological structure and flora of swamp eel (*Monopterus albus*)

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Introduction

Plastics are broken down by physical and chemical reactions into tiny particles of nanoplastics (NPs), which are easily dispersed in terrestrial and aquatic environments.

When ingested by aquatic organisms, NPs can lead to a range of serious problems, including respiratory distress, esophageal damage, gastrointestinal obstruction, digestive and metabolic disturbances, starvation, physiological disorders such as growth malformations, decreased immunity, metabolic disorders, and possibly even death.

Thus, in this study, we analyzed the effects of exposure to polystyrene nanoplastics (PS-NPs) (100 nm) on the digestive enzymes, intestinal structure, intestinal flora, liver immune response and apoptosis rate of *M. albus* based on physiological and biochemical indices. These results will provide further insight into the effects of PS-NPs on this and other freshwater benthic fish and provide a reference for the conservation of benthic organisms in aquatic ecosystems.

Methods

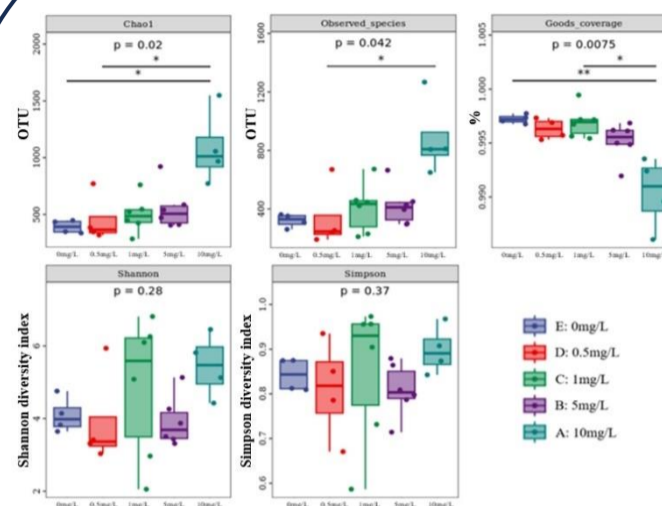
A suspension of spherical PS-NPs (0.1 μm , 10 mg/mL) was purchased from BaseLine ChromTech Research Center (Tianjin, China). Micro-characterization of the NPs was carried out by Fourier-transform infrared spectroscopy as previously described (Lu et al., 2016). In the current study, PS-NPs suspensions were prepared by adding the purchased stock solution to ultraviolet (UV)-disinfected aerated water.

A total of 900 acclimatized *M. albus* were randomly selected and divided into five groups of six replicates of 30 *M. albus* each. In the pre-test, no *M. albus* died after exposure to a PS-NPs concentration of 10 mg/L. On this basis, five treatment groups were established for the chronic toxicity test: (E) control group, no PS-NPs added (0 mg/L); (D) 0.5 mg/L PS-NPs; (C) 1 mg/L PS-NPs; (B) 5 mg/L PS-NPs; and (A) 10 mg/L PS-NPs. During the 28-day exposure period, *M. albus* was fed a commercial pelleted diet and supplemented daily (with fresh water only as a control) with the test solution to maintain a constant concentration.

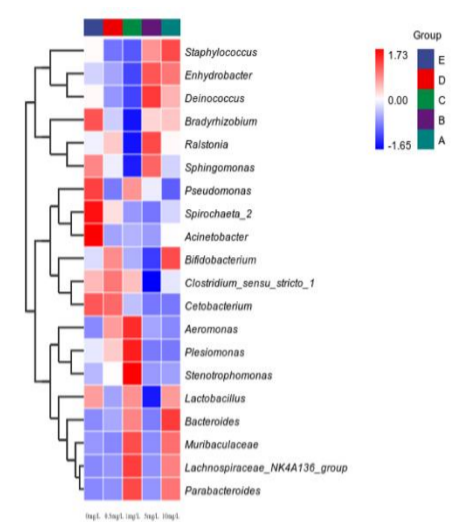
Conclusion

The physiological state of *M. albus* after exposure to different concentrations of PS-NPs was analyzed using qPCR and Illumina second-generation sequencing. Exposure to high concentrations of PS-NPs had a damaging effect on the intestinal structure of *M. albus*.

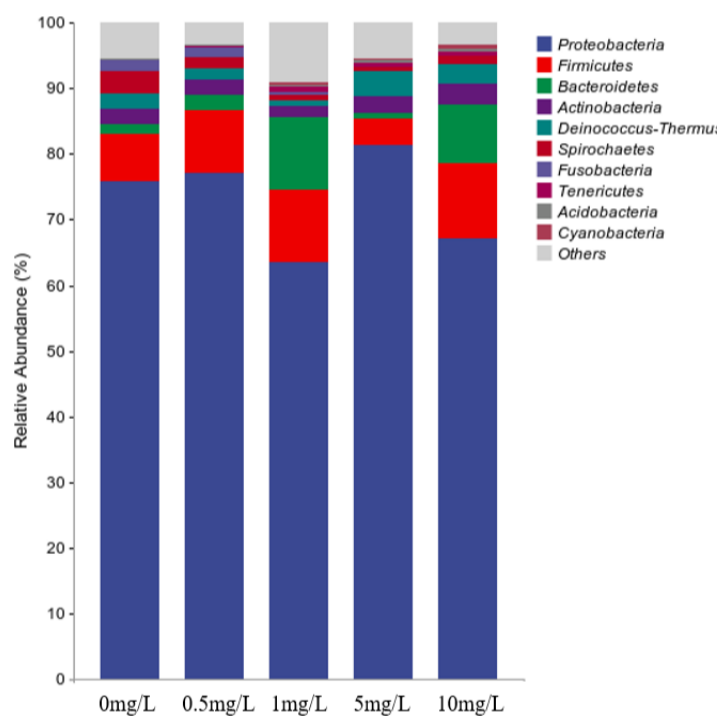
Results



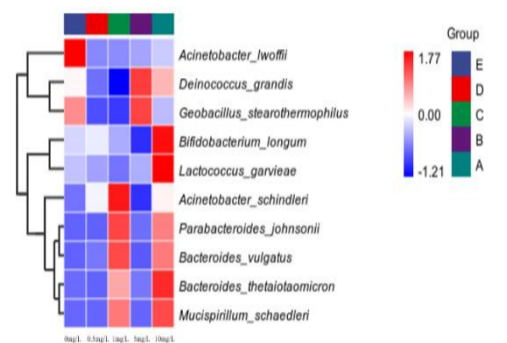
Comparison of alpha diversity indices of intestinal microorganisms in *M. albus* exposed to different concentrations of PS-NPs. Data are mean \pm SD.



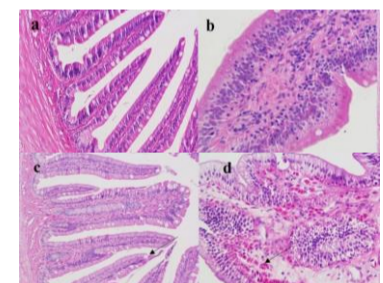
Changes in gut microorganisms at genus level in *M. albus* exposed to different concentrations of PS-NPs. The heatmap shows the relative abundance of the top 20 main identified bacteria at the genus level.



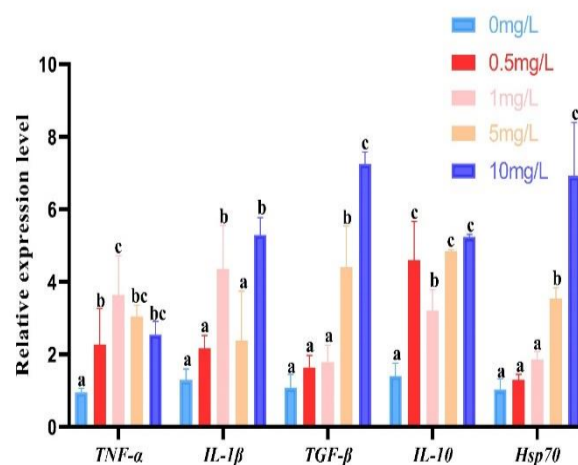
Effect of exposure to different PS-NPs concentrations on the gut microorganisms at the phylum level in *M. albus*.



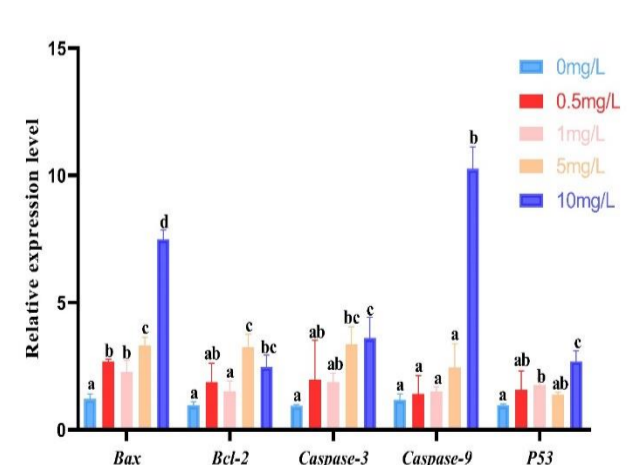
Changes in gut microorganisms at the species level in *M. albus* exposed to different concentrations of PS-NPs. The heatmap shows the relative abundance of the top 10 main identified bacteria at the species level.



Effect of exposure to different PS-NPs concentrations on the gut microorganisms at the phylum level in *M. albus*.



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Effect of exposure to different PS-NPs concentrations on the gut microorganisms at the phylum level in *M. albus*.