A study investigating the developmental and physiological effects of bioplastics and tire rubber leachates on the Mediterranean mussel, Mytilus galloprovincialis

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Abstract

As an alternative to conventional plastics, bioplastics are becoming increasingly popular; however, they do also contain some intentionally added (additives), and non-intentionally added (degradation or side products) chemicals. Thus, weathering of these bioplastics is thought to cause the leaching of these chemicals into the marine water. It is also estimated that their production will increase from 2.42 million tons in 2021 to 7.59 million tons in 2026. Therefore, their potential toxicity needs to be investigated. In this study, the seawater leachates of three biobased plastics (polylactic acid glasses, PLA, unknown supermarket biobags, SB, bio-polyethylene terephthalate mineral water bottles, BPT, and a conventional polymer (tire rubber, TR) were investigated to determine whether they adversely affect Mediterranean mussels during early life stages (eggs, sperms, embryos, and D-veliger larvae) and in adulthood. The early life stage endpoints, which included fertilization toxicity test, embryotoxicity, D-veliger immobilization, and survival rate, were assessed at 12 different leachate dilutions; a battery of cellular and molecular biomarkers was investigated in adult mussels exposed at 0.6% leachate concentration for 7 days. Leachates from SB and TR produced greater effects than those from PLA and BPT. During early life stages, the most affected endpoint was the inhibition of embryonic development; and the least affected endpoint was the survival of D-veligers. The effects of SB and TR on lysosomal membrane stabilization, lysozyme activity, and lipofuscin accumulation were also significant. In addition, leachates influenced other biomarkers as well. As a result, marine mussels have undergone ontogenetic and physiological changes due to mixtures of chemicals leached from bioplastics. Consequently, further studies are required before bioplastics can be considered a sustainable and right replacement for conventional plastics.

Keywords: Bioplastics, Mediterranean marine mussels, early life stages, biomarkers

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