

RESEARCH ARTICLE

Early Detection of the Heavy Metals Pollution Effect on Citarum River Using Zebrafish Muscle Mitochondria Biomarkers Gene Expression

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Abstract

Citarum is the longest river in West Java and one of the most polluted rivers in Indonesia and the world. Heavy metals from agriculture, industry, and household waste pollute the Citarum river. Heavy metals enter humans and animals by consuming contaminated food and beverages. Several studies have identified mitochondria as a primary target for heavy metal poisoning, resulting in impaired mitochondrial energy production, induction of oxidative stress, apoptosis, and mitophagy. This study aims to investigate the impact of heavy metals from the upstream and downstream areas of the Citarum river on mitochondrial gene expression of *cox4i1*, *sod2*, *baxa*, *mf1b*, and *ppargc1a* in the skeletal muscle of zebrafish (*Danio rerio*) using in vivo models for biological monitoring of early detection of environmental heavy metal pollution. This experimental study was conducted from December 2019 to March 2020. The study involved four treatment groups and one control group of zebrafish, which were exposed to river water and sediments collected from two sites in the Citarum river area in December 2019. The biomarker levels were analyzed using multivariate analysis. Although all heavy metal levels except mercury were below the WHO threshold in all samples, this study's results showed that the RT-PCR results indicated that the levels of *cox4i1*, *baxa*, and *ppargc1a* in all samples were generally higher than those in the control. There were significant differences ($p < 0.05$) using multivariate analysis in *sod2* in Cibeureum water compared to Cibeureum sediment and *ppargc1a* compared to control and Balekambang sediment. In conclusion, heavy metals from the upstream and downstream areas of the Citarum river had an impact on mitochondrial gene expression of *cox4i1*, *sod2*, *baxa*, *mf1b*, and *ppargc1a* in the skeletal muscle of zebrafish. Biomarkers *ppargc1gc* and *sod2* could be further studied to identify the most valid and reliable parameters for biological monitoring, which may aid in the early detection of environmental damage to humans and animals.

Keywords: Citarum river, heavy metals, mitochondria, muscle, zebrafish