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ORIGINAL ARTICLE

Detection of Zn^{2+} ions using a high-affinity low-molecular-weight fluorescence probe in two freshwater organisms

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Abstract

Objective The objective of this study was to determine the uptake and distribution of zinc ions (Zn^{2+}) in two freshwater organisms, *Moina macrocopa* and *Rheocricotopus* larvae using a high-affinity low-molecular-weight Zn^{2+}-ion-selective fluorescence probe.

Methods *M. macrocopa* and *Rheocricotopus* larvae were exposed separately to dissolved Zn^{2+} (0.1 and 1 mg/L) for 12, 24, and 48 h in three replicates along with a control. Later, the organisms were incubated with the fluorescence probe in six-well plates in the dark at room temperature. At the end of the incubation period, the organisms were washed with a phosphate buffer solution (0.01 M). The live organisms were then imaged using a fluorescence microscope and the fluorescence intensities of the images were determined.

Results The results revealed that the Zn^{2+} ions are uptaken and internalized into the bodies of the organisms exposed to Zn^{2+} ion concentrations, as indicated by a significant increase in the fluorescence intensities of the fluorescence images of the organisms. According to the fluorescence images, the Zn^{2+} ions were mainly localized in the lower gut region of *M. macrocopa* at the end of 48 h. However, in *Rheocricotopus* larvae, the Zn^{2+} ions were detected in the midgut region of the digestory tube after 48 h of exposure. Therefore, this was dependent upon both the Zn^{2+} concentration in the exposure media and the exposure duration.

Conclusion Taken together, the distribution of Zn^{2+} ions in different aquatic species is species-specific. Furthermore, the present study provides insight into the potential use of high-affinity low-molecular-weight Zn^{2+}-ion-selective fluorescence probes to detect labile Zn^{2+} in aquatic organisms and the toxicological implications of zinc pollution in aquatic environments.

Keywords Chironomids · Cladocerans · Fluorescence imaging · *Moina macrocopa* · Heavy metals · *Rheocricotopus* larvae

Introduction

Zinc (Zn) is one of the common trace metals found in the natural environment and it is essential in the metabolism of living organisms in terrestrial and aquatic habitats. An optimum level of Zn in living organisms works as an essential microelement. It plays several roles in their bodies, including participation in the growth and development, proteins and energy metabolism, and immunity, and it is needed to form both DNA and RNA polymerase enzymes [1, 2]. Though Zn is an essential micronutrient, the presence of large quantities of Zn in the aquatic environment in recent years has severely degraded the quality of aquatic ecosystems [3]. For example, the toxic effects of Zn in the aquatic environment have resulted in decreased biodiversity [4] and changes in species abundance and composition [5]. In addition, aquatic organisms are generally more sensitive to Zn pollution than

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