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# Environmental Toxicology and Ecological Risk Assessment

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## Toxicity of metal mixtures to aquatic organisms: Additive and non-additive effects

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**M**etal mixture toxicity has been studied for decades. However, most of the studies have focused on acute toxic effects. While metals are stable in the natural environment, chronic exposures are more relevant than acute exposures. This presentation summarizes the results of the 21-d chronic toxicity studies on the binary metal mixtures of cadmium (Cd) and zinc (Zn), Cd and nickel (Ni) and Cd and chromium (Cr) to *Daphnia Magna*. The titration design was used in these studies to determine the toxic effects of the binary metal mixtures on survival, growth, reproduction and metal accumulation in *D. magna*. Using this design, increasing concentrations of Cu, Ni and Zn were titrated against a constant concentration of Cd. The results demonstrate that the mixture effects can be additive and non-additive and are dependent on metals and concentrations. In a mixture with Cd and Zn, concentrations of 10 and 20 µg/L Zn were consistently insufficient to protect *D. Magna* from chronic Cd toxicity, while mixtures containing 40, 80 and 120 µg/L Zn provided strong protective effects to *D. magna* at all endpoints. Higher Zn concentrations of 160 were too excessive and no protective effects were observed. On the other hand, moderate Ni concentrations of 20, 40 and 80 µg/L were found to strongly protect *D. magna* from chronic Cd toxicity while higher Ni concentrations ( $\geq 100$  µg/L) were too excessive and Ni protective effects were absent. For Cd-Cu mixture, the effects appeared to be less than additive at Cu concentrations  $\leq 3$  µg/L. Above this Cu concentration, the effect was additive. In general, metal accumulation in *D. magna* was corresponding the observed toxicity. Embryos analyzed for morphological alterations demonstrate severe developmental defects. The results of the present study are useful for the development of environmental quality guidelines for metal mixtures.

### Biography

Tham Hoang received a MS and PhD in Environmental Toxicology from Clemson University at the age of 30 years. After graduation, he worked for Florida Integrational University as the postdoctoral associate and visiting research faculty. He joined Loyola University Chicago in 2011 and became an associate professor in 2017. He has about 18 years of doing environmental toxicology research with a strong focus on metal and pesticide toxicity and risk assessment in support of the development of environmental quality guidelines. He has chaired and organized 3 International Conferences on Environmental Pollution, Restoration and Management in Vietnam and 7 workshops and symposium on environmental toxicology and risk assessments of contaminants in the past 15 years in the Lower Mekong Basin countries. He also served on the organizing and scientific committees of the Annual Meetings of the Society of Environmental Toxicology and Chemistry in North America and Asia Pacific Region for several times.

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