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The Role of EDTA and EDDS in Reducing Metal Toxicity for Aquaculture Shellfish Perna canaliculus

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Abstract : The chelating agent ethylenediaminetetraacetic acid (EDTA) is commonly added as a cure-all to seawater in aquaculture hatcheries around the world to reduce heavy metal toxicity, significantly improve the survival of larval shellfish, and to therefore improve the overall production efficiency of the aquaculture industry. However, EDTA is not a biodegradable chemical and is considered to be a persistent organic pollutant, which will accumulate in the environment over time. This makes the use of EDTA unsustainable environmentally, and therefore alternatives should be considered. Ethylenediaminedisuccinic acid (EDDS) is a biodegradable alternative to EDTA with very similar metal chelation properties. This study investigates the effect of EDTA and EDDS at two different concentrations, on metal concentrations found within developing New Zealand green-lipped mussel (Perna canaliculus) larvae. P. canaliculus is New Zealand's main shellfish aquaculture species, providing a major export for New Zealand's economy, with excellent potential for increased production in the near future. It is well known that the early stages of bivalve development are the most vulnerable to metal toxicity and P. canaliculus is no exception. The commercially used concentration (12 µmol L^{-1}) of EDTA added to P. canaliculus larval rearing tanks often increases the yield of D-larvae by over 80%. This concentration of EDTA and EDDS will be tested in this study, along with a lower concentration (3 µmol L^{-1}). After 48 hours of larval development, the D-larvae will be analyzed for heavy metal content with Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and heavy metal distribution with synchrotron X-ray Fluorescence Microscopy (XFM). In this study, we found that EDDS also improves the yield of P. canaliculus larvae and could be a viable alternative to EDTA in aquaculture. Furthermore, results suggest a higher concentration of chelating agent is more effective for improving the yield of developing P. canaliculus larvae. Metals with significant differences in concentration with the addition of EDTA were Cr, Cu, Zn, Cd and Pb ($P < 0.05$). We observed for the first time to the author's best knowledge, metal distribution within 100 µm P. canaliculus D-larvae using synchrotron XFM and found changes in the distribution of metals with the addition of EDTA. XFM also has the potential to provide information about the chemical state of the metals within mussel larvae. This research provides greater insight into the reasons for the effectiveness of adding the chelating agent to aquaculture culture water, and a more environmentally conscious alternative to the currently used EDTA, which could be extremely valuable for the aquaculture industry.

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