The effects of dissolved organic carbon on copper toxicity to the development of the oyster embryo

Introduction

The toxicity of waterborne copper to aquatic organisms is highly dependent on its chemical form (Di Toro et al., 2000). The most bioavailable and subsequently toxic form is the free copper ion. However, in aquatic systems, the free copper ion has a strong tendency to form complexes with both inorganic and organic ligands, which results in a reduction in its overall toxicity. Although the inorganic copper species are believed to be bioavailable to a certain extent (MacRae et al., 1999), copper complexed with organic matter is considered non-bioavailable and thus non-toxic. Consequently, factors that can influence the speciation of copper within a particular environment are likely to have significant effects on the metals toxicity to aquatic organisms.

Aims

This study investigates the effects of dissolved organic carbon (DOC) on copper speciation and its bioavailability and subsequent toxicity to the early life stages of the Pacific oyster, Crassostrea gigas, following a 24 h exposure.

Method

Flow-through system

For copper toxicity testing, an equilibration time of at least 24 h is essential to enable the reaction kinetics of copper to stabilise prior to expose to the test organism (Ma et al., 1999). A flow-through dosing system was used to expose oyster embryos to constant copper concentrations after a 24 h equilibration time (see Figure 1). Copper chloride used as the stock solution and humic acid (HA) as the source of dissolved organic carbon (DOC).

Oyster embryo Bioassay

Conditioned oysters were obtained from Guernsey Sea farms Ltd. Male and female gametes were physically separated from the gonad and placed in filtered seawater. The sperm and egg suspensions were filtered to remove debris and combined in a ratio of 1:100. Eggs were considered appropriate for testing when greater than 80% of cells had reached the 16-32 cell stage. Egg suspensions were filtered to remove debris and combined in a ratio of 1:100. Eggs were held in 10 l holding chambers with 20% (v/v) sodium tetraborate buffered formaldehyde solution. The test was carried out at 14 ± 1 °C, 14 h light: 10 h dark, 20% (v/v) seawater.

Results

Figure 1: The Biotic Ligand Model for copper speciation

Figure 2: Schematic representation of the laboratory flow-through system for copper dosing. FM-Flow meter; HA – humic acid; PP- peristaltic pump; PS – protein skimmer; RT - residence time; SW – seawater.

Table 1: Physicochemical and ionic readings of the seawater within the experimental tank during the separate oyster embryo bioassays. Values represent means and standard deviations of readings taken at the start and end of each test from all experimental tanks (i.e. control n=12, all other tests n=4)

Table 2: Summary table of ecotoxicity test data. NOEC-No observable effect concentration, LOEC – Lowest observable effect concentration

Summary

The proportion of Labile Copper (LCu) to Total dissolved copper (TDCu) was affected by Ionic concentration by ion chromatography (start of test only); This study has shown that DOC provided protection for the development of 1.5 times than LCu to the OEB. The addition of DOC had no significant effect on the EC50 of LCu to the OEB.

Acknowledgments

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References


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