

The effect of short-term Cu exposure on the oxygen consumption and Cu accumulation of mudfish (*Labeo capensis*) and the largemouth bass (*Micropterus salmoides*) in hard water

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Abstract

Sediment samples from 3 dams near the gold-mining area in the Mooi River catchment, South Africa, and fish tissue from the mudfish (*Labeo capensis*) and largemouth bass (*Micropterus salmoides*) were analysed for Cu to assess environmental pollution. Copper concentrations of sediment samples in 50 mm deep profiles at Klerkskraal Dam (22.2 mg Cu·kg⁻¹), Boskop Dam (14.1 mg Cu·kg⁻¹) and Potchefstroom Dam (21.7 mg Cu·kg⁻¹) and profiles 100 mm and 150 mm deep were above the risk assessment values for Cu, as implemented by the US EPA. Lowest Cu concentrations were found in gonads and blood samples in fish from both species in the 3 dams, but accumulated 3 to 5 times more, to 110.1±17.8 mg Cu·kg⁻¹ dry mass in the liver. After 120 min Cu exposure at 20°C to 10 mg Cu·l⁻¹ (157.3 mmol Cu·l⁻¹) and a 96 h Cu exposure to 1 mg Cu·l⁻¹ (15.73 mmol Cu·l⁻¹) Cu accumulated mainly in liver tissue and gills. For the mudfish, upon exposure to 10 mg Cu·l⁻¹ (157.3 mmol Cu·l⁻¹), the opercular frequency increased significantly from 80 (± 5.7) cycles·min⁻¹ to above 100 (± 5.8) cycles·min⁻¹ after 90 min, but thereafter decreased to zero cycles·min⁻¹. For largemouth bass the same increase in opercular frequency was found during 10 mg Cu·l⁻¹ exposure, but this Cu level did not stop opercular frequency. For *L. capensis* the oxygen consumption rate MO₂ for the two hour exposure period at 10 mg Cu·l⁻¹ decrease significantly from 5.17 (± 0.32) mmol O₂·l⁻¹·kg⁻¹·h⁻¹ for the controls to 4.5 (± 0.37) mmol O₂·l⁻¹·kg⁻¹·h⁻¹ and for experimental *M. salmoides* from 4.91(± 0.45) mmol O₂·l⁻¹·kg⁻¹·h⁻¹ to 3.13 (± 0.74) mmol O₂·l⁻¹·g⁻¹·h⁻¹. For the exposure period of 96 h at 1 mg Cu·l⁻¹, MO₂ for both fish species, decreased to 2.9 (± 0.3) mmol O₂·l⁻¹·kg⁻¹·h⁻¹. It is concluded that:

- The imported *M. salmoides* from the USA is biologically more tolerant to acute Cu exposure compared to the endemic mudfish, *Labeo capensis*
- For the 2 fish species Cu accumulates mainly in the liver, followed by the gills and kidney
- [Cu] above 20 mg Cu·kg⁻¹ dry sediment may be released in the water column if the pH value decreases below 5 and, together with the physical disturbance of the sediment layer, acute Cu pollution will be the result
- Copper is about 10 times more toxic for the 2 fish species studied compared to Pb and Cd in hard water as found in previous studies.

Keywords: Cu, sediment, fish, MO₂, opercular frequency, hard water