

Acute toxicity of copper and cadmium for piauçu, *Leporinus macrocephalus*, and curimatã, *Prochilodus vimboides*

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ABSTRACT. Ninety-six-hour static bioassays were conducted in the laboratory to determine lethal concentrations (96-h LC₅₀) of copper and cadmium for curimatã (*Prochilodus vimboides*) and piauçu (*Leporinus macrocephalus*). The 96-h LC₅₀ of copper were 0.047 and 0.090 mg L⁻¹, and of cadmium 3.16 and 7.42 mg L⁻¹ for curimatã and piauçu, respectively. Curimatã is a preferred indigenous species for toxicological studies in the Doce River basin due to its availability in the hatcheries of the region and high sensitivity to metals.

Key words: lethal concentration, Doce river, Southeast region, fish and metal.

RESUMO. Toxicidade aguda do cobre e do cádmio no piauçu, *Leporinus macrocephalus*, e no curimatã, *Prochilodus vimboides*. Bioensaios estáticos foram realizados em laboratório para determinar a concentração letal (96-h CL₅₀) do cobre e do cádmio para o curimatã (*Prochilodus vimboides*) e o piauçu (*Leporinus macrocephalus*). A CL₅₀ do cobre é de 0,047 e 0,090 mg L⁻¹ e do cádmio de 3,16 e 7,42 mg L⁻¹ para curimatã e piauçu, respectivamente. O curimatã é a espécie nativa mais adequada para estudos toxicológicos da bacia do rio Doce, por sua fácil disponibilidade em pisciculturas da região e alta sensibilidade aos metais.

Palavras-chave: concentração letal, rio Doce, região Sudeste, peixe e metal.

Introduction

The Doce River hydrographic basin, located in the Southeast region of Brazil (Minas Gerais and Espírito Santo States), hosts the largest iron mining and processing complex in Latin America and is an important agricultural region. Consequently, its water bodies are subject to a wide range of contaminants. Contamination with metals is the main issue to be considered when evaluating the water of the basin. Pires et al. (2003) found traces of metals in containment ponds at a local iron processing facility. Some pesticides used locally also contain metals, mainly copper (OLIVEIRA-FILHO et al., 2004). Among the metals found in the water bodies of this basin, copper (Cu) and cadmium (Cd) can be toxic to fish (McGEER et al., 2000; MATSUO et al., 2005; WU et al., 2007); hence the great importance of studying these metals in this environment.

Piauçu (*Leporinus macrocephalus*), and curimatã (*Prochilodus vimboides*), are Brazilian indigenous species with the greatest availability from hatcheries in the region, which makes the species natural candidates for standard fish species in toxicological

studies in the Doce River basin. The objective of this study was to verify the acute toxicity of copper and cadmium to juvenile piauçu and curimatã.

Material and methods

Juvenile curimatã (1.5 ± 0.7 g; mean ± SD) and piauçu (2.4 ± 0.8 g) were obtained at the fish hatchery of the Federal Agrotechnical School of Colatina (Colatina, Espírito Santo State, Brazil). Fish were acclimated separately in aerated static 500-L fiberglass tanks for 15 days prior to experimental procedures. Fish were fed daily with commercial pellets (36% crude protein; 1.6% Ca²⁺) and 50% of the water in each tank was replaced every 3 days.

The 96-h median lethal concentration (96-h LC₅₀; lethal concentration for 50% of the organisms) of copper and cadmium was determined. Fish were exposed to different metal concentrations and to a control (no metal added to water) in triplicate groups in 30-L aerated glass aquaria, each containing 25-L of test water and 10 fish. Fish were transferred to an aquarium 24-h prior to metal addition and starved until the end of the experiment. Piauçu and curimatã were exposed to nominal copper (as

CuSO₄·5H₂O from Synth, São Paulo, Brazil) concentrations of 0.05, 0.1, 0.15, 0.20, 0.25 and 0.30 mg L⁻¹ and 0.02, 0.04, 0.06, 0.08 and 0.10 mg L⁻¹, respectively, and nominal cadmium (as CdCl₂·H₂O from Synth, São Paulo, Brazil) concentrations of 3.7, 10.0, 14.0, 19.0 and 27.0 mg L⁻¹ and 1.5, 2.2, 3.2, 4.6 and 6.8 mg L⁻¹, respectively. During the 96-h LC₅₀ test, dead fish were removed once a day. The Trimmed Spearman-Kärber method was used to calculate 96-h LC₅₀ values (HAMILTON et al., 1977). Water quality during the tests was: temperature 27.3 ± 0.1°C, dissolved oxygen 7.98 ± 0.05 mg L⁻¹, pH 7.26 ± 0.05, total hardness 40 ± 8 mg L⁻¹ CaCO₃, Na⁺ 4.5 ± 1.1 mg L⁻¹ and Ca²⁺ 6.4 ± 0.80 mg L⁻¹.

Results and discussion

Water quality during the tests was in accordance with the guidelines for acute toxicity bioassays of the Brazilian Association of Technical Norms (ABNT, 2004). Water hardness was similar to that of the Doce River (40-50 mg L⁻¹). This similarity is important for a direct extrapolation of the results, because water hardness can alter copper and cadmium toxicity (PERSCHBACHER; WURTS, 1999; MATSUO et al., 2005).

The lethal concentration of copper for curimatã was about half that for piaçu (Table 1) and about 13 times lower than the one reported by Masutti et al. (2006) (0.590 mg Cu L⁻¹; water hardness: 40-48 mg L⁻¹ CaCO₃) for Nile tilapia from this area of Brazil. This result showed that curimatã is highly sensitive to Copper effects. The 96-h LC₅₀ estimate of copper for *Prochilodus scrofa* (0.029 mg L⁻¹; water hardness: 25 mg L⁻¹ CaCO₃) (MAZON et al., 2002) is similar to that for *P. vimboides*, indicating that fishes within this genus have a similar response to this metal. The 96-h LC₅₀ estimate of copper for zebrafish *Danio rerio* (OLIVEIRA-FILHO et al., 2004), the standard freshwater fish in toxicological studies by several regulatory agencies (ABNT, 2004) was 0.083 mg L⁻¹ (water hardness: 44 mg L⁻¹ CaCO₃), and is similar to the one observed for piaçu and two times higher than that for curimatã.

Table 1. The 96-h LC₅₀ of copper and cadmium for curimatã and piaçu. The 95% confidence interval is in parentheses.

Fish species	96-h LC ₅₀ (mg L ⁻¹)	
	Copper	Cadmium
Curimatã	0.047 (0.042-0.052)	3.16 (2.90-3.40)
Piaçu	0.090 (0.080-0.100)	7.42 (6.64-8.29)

The 96-h LC₅₀ estimate of cadmium for curimatã is also about half that for piaçu (Table 1). The 96-h LC₅₀ of cadmium for Nile tilapia was 14.8 mg L⁻¹ (water hardness: 50 mg L⁻¹ CaCO₃) (GARCIA-SANTOS et al., 2006) and is four times higher than the one obtained for curimatã and two times higher than that for piaçu. According to the Garcia-Santos et al. (2006) study, Nile tilapia is one of the most tolerant freshwater teleost fish to cadmium, while curimatã is one of the least tolerant fish. On the other hand, temperate fishes like rainbow trout *Oncorhynchus mykiss* (96-h LC₅₀ 1.3 mg L⁻¹; water hardness: 30 mg L⁻¹ CaCO₃) (PASCOE et al., 1986), a standard temperate fish used in acute lethality tests (SPRAGUE, 1990), is more sensitive to cadmium than tropical fishes. The differences in species sensitivity to cadmium may relate to different physiological strategies for calcium regulation (e.g., structurally different gills, differences in calcium uptake mechanisms, or different resistance to calcium loss) (HANSEN et al., 2002).

Curimatã and piaçu are more sensitive to copper and cadmium than other tropical fishes; however, curimatã was more sensitive than piaçu, to both metals (Table 1). A different magnitude of acute toxicity between metals was also observed, with copper being about 75 times more toxic to tested fishes than cadmium (Table 1).

According to Sprague (1990), in order to evaluate a local problem, a sensitive species of regional predominance might be better than standardized species. Therefore, curimatã should be a preferred fish species in studies concerning toxicological effects of metals in the Doce River basin, because it is more sensitive to metal contamination than other tropical species.

Acknowledgments

This work was supported by grant #10/2007 from UVV. The authors would like to thank the Federal Agrotechnical School of Colatina for the donation of fishes, and Dr. Richard Brinn for the critical review of the manuscript and English corrections. L. C. Gomes is a research fellowship recipient from CNPq.

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Received on September 17, 2008.

Accepted on December 5, 2008.

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