ABSTRACT

Laboratory studies of the acclimation of freshwater-held Red hybrid tilapia to brackish water revealed that the fish readily acclimated to sea water through gradual exposures to increasing salinities. Behavioral adaptations to 6.5‰, 13.1‰, and 16.5‰ sea water were achieved within 12, 12, and 96 hours, respectively, however direct transfer to full strength sea water (33‰), resulted in 100% mortality within 6 hours of exposure.

Aeration significantly ($P<0.05$) affected the dissipation of chlorpyrifos from tap, river, and brackish waters in glass aquaria under laboratory conditions with dissipation being fastest in river, followed by brackish > tap waters under both experimental conditions. The half-lives in aerated and unaerated (data in parentheses) river, brackish, and tap waters were 3.19 (59.52), 5.77 (231.84), 23.07 (403.44) h, respectively. Up to 12% of the initial chlorpyrifos concentration in aerated tap water adsorbed to glass surfaces of the aquaria

The 96-h LC_{10}, LC_{50}, and LC_{95} values for chlorpyrifos toxicity to Red hybrid tilapia were 0.116, 0.128, and 0.146 mg/L, respectively. Fish subjected to 4-d renewal exposures of sublethal concentrations for 28 days in fresh and in brackish waters, displayed a number of toxic symptoms including darting, shuddering, and side-swimming. There was no significant difference ($P > 0.05$) between the number of fish responding to toxic stress in freshwater compared with brackish water. The No-Observable-Effect-Concentrations (NOECs), estimated by Probit Analysis of the data, were 0.00031 and 0.0001 mg/L in fresh and brackish water, respectively. The

concentrations causing observable toxic effects in 10, 50, and 95% of fish (OEC_{10}, OEC_{50}, OEC_{95}) in fresh and brackish water (data in parentheses) were 0.135 (0.0047), 0.0375 (0.0133), 0.1393 (0.0510) mg/L, respectively. A reciprocal relationship between the time taken for fish to respond and the exposure concentrations was observed.

Twenty-four hour renewal exposures of fish to a sublethal concentration (0.05 mg/L) of chlorpyrifos in fresh and brackish water for 72 hours resulted in rapid accumulation of the insecticide by the fish, with maximum concentration factors (ratio of insecticide concentration in fish to water) MCF_is of 31.08 and 23.55 mL/g, for fresh- and brackish-water exposures, respectively. Exposure of fresh- and brackish-water-held fish to 0.005 mg/L of chlorpyrifos for 96 hours, during spike-exposure with the insecticide at regular intervals, resulted in MCF_is of 828.26 and 431.42 mL/g, respectively.

Chlorpyrifos was rapidly eliminated by Red hybrids in fresh water, following their exposure to 0.05 mg/L of the insecticide and subsequent introduction to uncontaminated water. Here, elimination was significantly ($P < 0.05$) faster than in brackish water; whereas 72% of the initial concentration in the body of the fish was eliminated within the first 12 hours of introduction to clean freshwater, only 23% was eliminted by fish in brackish water during this time. Overall, 76 and 41% of the residues were eliminated in fresh and brackish water, respectively, after 72 hours.

Following 72-h exposure of fish to 0.005 and 0.05 mg/L of chlorpyrifos in freshwater, the order of the major sites of residue accumulation was the testes > heart > brain > ovaries > liver > eyes > gut > gills > skin-muscle-bone (SMB); the orders of distribution upon exposure of fish to 0.005 mg/L and 0.05 mg/L of chlorpyrifos in brackish water were testes > heart >ovaries > brain > eyes > liver > gut > gills > SMB, and heart >brain > testes > ovaries > liver > eyes > gills> gut > SMB, respectively.

The uptake and elimination of chlorpyrifos fitted a four-compartment fish/water model with uptake rate constants (K_1) ranging between 1144-15466 mL-g^{-1}-day^{-1}.

Preliminary risk assessment of chlorpyrifos in a simulated environment suggested that the insecticide is hazardous to fish and should be further assessed