Bioassay Determination of Environmentally Safe Levels of Atenolol, Carbamazepine, and Ibuprofen in Waterways

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Potential "newly emerging contaminants" in waterways are being evaluated. Unused or excreted pharmaceuticals may pose threats to aquatic organisms. This arouses concern since the EPA has not fully regulated pharmaceuticals in wastewater treatment. This research investigated effects of three pharmaceuticals detected in waterways and wastewater-treated effluent: atenolol, carbamazepine, and ibuprofen. Detrimental effects on bioindicator organisms at mean and maximum EPA-reported concentrations in wastewater-treated effluent of atenolol and carbamazepine were previously reported. Studies at the EPA mean and maximum levels of ibuprofen and at lower concentrations of all three pharmaceuticals were conducted to find an environmentally safe level. Atenolol and ibuprofen were tested in cultures of Daphnia magna, and carbamazepine in Dugesia tigrina. At mean and maximum EPA-levels, atenolol (studied in 2013-14) and ibuprofen (newly studied), daphnia appeared pale and showed reduced heart rates. In replicate runs, daphnia treated at the EPA-reported mean exhibited heart rates lower than the control ($p<<0.00001$). At EPA-maximum concentrations heart rates were further reduced from that at the EPA-mean ($p<<0.001$). At the newly studied 10% and 25% of the mean and maximum EPA-reported concentrations, heart rates were similar to the control. Carbamazepine (2013-14) had shown detrimental effects on the regeneration of transversely-bisected planaria at the mean and maximum EPA-detected values, and sizes decreased with time as the organisms disintegrated. At 10% and 25% of the mean and maximum reported levels, planaria regeneration was not distinguishably different from the control. An environmentally safe level was found at least within 25% of the maximum EPA-reported concentrations.

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