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Effects of Atrazine on Insecticide Toxicity and Gene Expression in the Aquatic Midge, Chironomus Tentans (Diptera: Chiromomidae)

Abstract: The triazine herbicide atrazine is an extensively used pesticide in the agricultural and residential areas of the U.S. and has been routinely detected in many surface and ground waters. The use of atrazine has resulted in many deleterious effects on aquatic non-target organisms that reside near atrazine-treated areas. This study was conducted to evaluate the effects of atrazine on the toxicity of selected organophosphate insecticides and gene expression using fourth-instar larvae of the aquatic midge, Chironomus tentans. Atrazine alone up to 1000 µg/L did not show significant toxicity to the midges. However, atrazine concentrations from 1 to 1000 µg/L significantly enhanced the toxicity of dimethoate, disulfoton, or demeton-S-methyl when in combination. In contrast, atrazine at 10 µg/L in combination with omethoate significantly decreased the insecticide toxicity. Biochemical analysis indicated that increased toxicity of dimethoate, disulfoton, and demeton-S-methyl in binary combination with atrazine correlated to the increased inhibition of acetylcholinesterase. Furthermore, cytochrome P450-dependent O-deethylation activity in the atrazine-treated midges was 1.5-fold higher than that in the controls. Cytochrome P450 induction by atrazine may lead to increasing organophosphate toxicity by enhancing the oxidative activation of the insecticides into oxon or sulfoxide analogs with increased anticholinesterase activity. To better understand the molecular basis of atrazine's effects in C. tentans, we used a toxicogenomics approach know as restriction fragment differential display (RFDD)-PCR to systematically compare gene expression profiles between atrazine-treated and –untreated midges. Fifty-six up- and 60 down-regulated genes were tentatively identified in response to atrazine exposure. Atrazine appears to affect the expression of many genes that are either toxicologically or physiologically important to C. tentans. This study is expected to provide insights into the risk assessment for atrazine and identify atrazine-specific marker genes that can be potentially used to evaluate non-target effects of atrazine and aquatic environmental health.

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